SEAFDEC
Asian Aquaculture

In this issue **Seaweed culture**

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ON THE COVER

AQD attempts to replant Sargassum, *a seaweed known to be difficult to propagate, in west central Philippines.*
PHOTO By R Buendia

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AQD to conduct mollusc training, convene mudcrab symposium

Plans are underway to hold an international training on molluscs and an international symposium on mudcrab. A training course on **Culture and Biology of Edible Molluscs** will be sponsored jointly by the Danish International Development Agency, SEAFDEC Aquaculture Department and the SEAFDEC Secretariat. It will be held in Iloilo City but the date will be announced later.

The training will cover molluscan taxonomy and biology (gastropods, bivalves, and cephalopods); collection / maintenance of broodstock, induced spawning; culture techniques; transportation of spat, farm management; genetics, conservation biology, domestication of molluscs; seafarming / searanching, artificial reefs, stock enhancement. Target participants include aquaculturists from Vietnam and other SEAFDEC Member-Countries.

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The **International Forum on the Culture of Portunid Crabs with Emphasis on *Scylla* Species** will be held December 1-4, 1998 tentatively set at The Pink Patio, Boracay Island (north of Iloilo City). This forum is sponsored by the Government of Australia, SEAFDEC Aquaculture Department, FAO / NACA, DANIDA, and JICA.

The forum will review the status of research on crab culture and identify problems and research directions for larval rearing and grow-out culture with emphasis on environmental concerns. It will also provide a forum for interaction between scientists and industry practitioners.

Forum topics will include biology, ecology and physiology; seed production; culture systems; nutrition and feeds; diseases and environmental issues; genetics and biotechnology; socio-economics; processing; and marketing.

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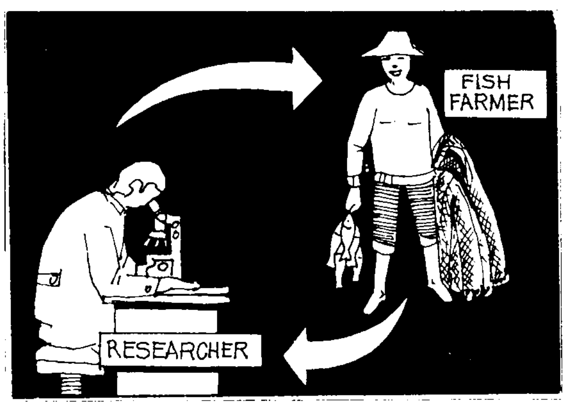
1997: AQD'S YEAR OF LINKING WITH THE INDUSTRY



By **M Castaños**

1997 was a good year for AQD. Its research output, currently measured in terms of the number of scientific papers published, has improved over 1996. For 1997, a total of 39 papers were published in scientific journals and other publication. With 59 senior research staff, this means 0.7 paper per researcher. In all, AQD continued to contribute quality research information, the first step in technology generation.

As for technology verification and technology demonstration, AQD packaged and field-tested various technologies (10 projects in all). These were conducted in private fishfarms in west central Philippines.

The recurrent themes of AQD's research and development efforts seem to be poverty alleviation, food security issues, environment-friendly techniques, and export or cash crops. A few notable examples in 1997:

- The community fishery resource management (CFRM) project in Malalison Island
- The technical assistance to local government units on low-input aquaculture produce like tilapia and mussel-oyster
- The development of mudcrab culture techniques in reforested mangrove areas
- The continued research on high-value species like tiger shrimp and 20 or so species of economic importance in southeast Asia. About 27 research projects were implemented in 1997. Another 21 studies are collaborations with various organizations and agencies.

In terms of technology transfer, AQD continued to train aquaculture manpower (94 attended six short-term training courses and more than 170 availed of individual training programs). AQD for the first time conducted training outside the Philippines, the *Sustainable Aquaculture and Coastal Resource Management* at Cantho University in Vietnam. AQD also got involved in the revision of the curriculum leading to the Diploma in Fishery Technology of

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Centennial fisheries award for AQD

By **MB Surtida**

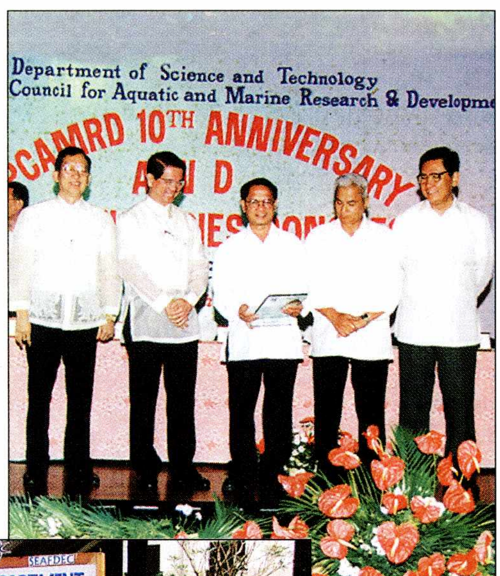
AQD staff receive research awards every now and then but none as significant as this recent award given to the institution itself. On January 30, 1998, AQD was awarded the **Centennial Fisheries Award** by the (Philippine) Department of Science and Technology for Most Outstanding Fisheries.

The award is for "pioneering the development of the prawn hatchery technology in the 1970's led by Dean Domiciano K. Villaluz, which boosted prawn production in the country." The award carried with it a ₱ 50,000 cash prize. (Prawn is the popular industry term for the tiger shrimp *Penaeus monodon*.)

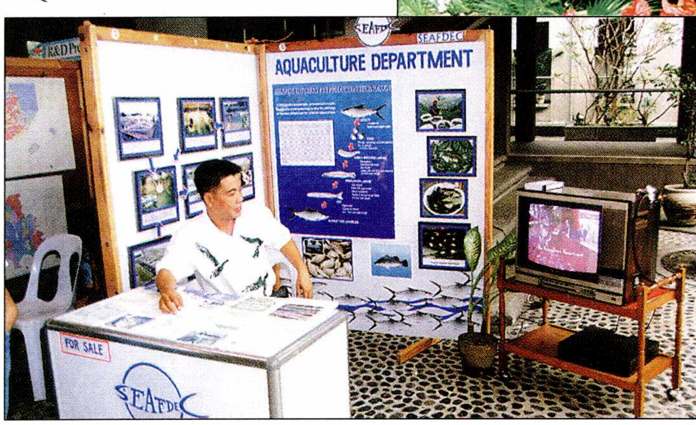
In 1974, the Philippines had not developed its prawn culture industry. Shrimps were harvested in milkfish farms, properly called incidental crops. Ten years later after AQD started its prawn research, industry recommendations in the areas of maturation, hatchery, nursery, and pond grow out were generated. Shrimp production increased from 1,805 tons in 1982 to 26,360 tons in 1984. Clearly, it was the sunrise industry.

The late 80's saw the decline in shrimp production. Now AQD is in the thick of research in disease prevention and control in hatcheries and ponds, and in feed development for various life stages. Alternate culture systems are also being explored such as the plastic lined ponds and shrimps-in-mangroves.

AQD receives a centennial fisheries award for its tiger shrimp R&D, here represented by Training and Information Head Mr. Renato Agbayani (center, holding plaque), during the 10th anniversary of DOST - PCAMRD. With Mr. Agbayani are (left to right): PCAMRD Director Rafael Guerrero III, DOST Secretary William Padolina, former DOST Secretary Angel Alcala, and Cong. R Montemayor, the sectoral representative for farmers and fisherfolk.



The AQD exhibit in the same affair.



AQD's sister department in Malaysia

By **E Aldon**

SEAFDEC is not only aquaculture, it is also marine fishery resources.

The latest department to be formed in the SEAFDEC family is MFRDMD -- the Marine Fishery Resources Development and Management Department -- based in Kuala Terengganu, Malaysia. It provides assistance to SEAFDEC Member-Countries, including the Philippines, in the use of their respective EEZs or exclusive economic zones, while serving as a regional forum for cooperation and consultation. EEZ defines a country's territorial waters.

PHOTOS COURTESY OF MFRDMD / SEAFDEC

MFRDMD's research activities include --

(1) A cruise-survey of fishery resources in the waters off Thailand and Malaysia. MFDRMD compiles catch effort statistics for fish stock assessment of the South China Sea. It also collates tuna fishery statistics for southeast Asia, a responsibility of the Indo-Pacific Tuna Develop

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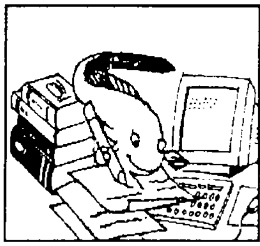


AQD Research Publications

Reprints of papers listed here may be requested from AQD authors.

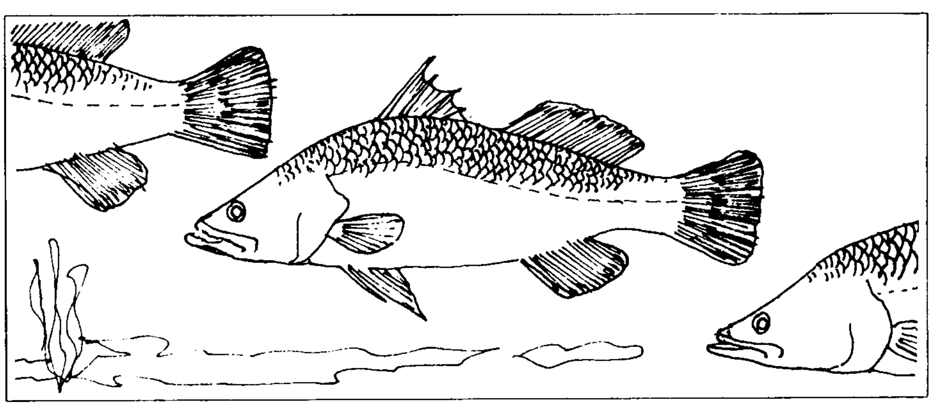
Compiled by the AQD LIBRARY

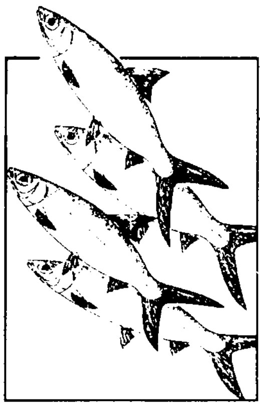
Fermin AC, GA Seronay. 1997. Effects of different illumination levels on zooplankton abundance, feeding periodicity, growth and survival of the Asian sea bass, *Lates calcarifer* (Bloch), fry in illuminated floating nursery cages. Aquaculture 157: 227-237 --

The effects of different illumination levels on zooplankton abundance and feeding periodicity, growth and survival of hatchery-produced Asian sea bass, *Lates calcarifer*, fry in illuminated floating net cages were determined in a 35-day experiment. Zooplankton abundance (consisting mainly of copepods at 64-78% of total abundance in all cages) was highest in cages illuminated at 180 lx (mean: 124 individuals l^{-1}) and at 300 lx (mean: 405 individuals l^{-1}) and peaked at 0400. High prey densities subsequently resulted in increased fish feeding as evidenced by the greatest number of prey (mean: 416-462 individuals fish^{-1}) found in their guts between 0400 and 0800. Feeding incidence (range: 84-89%) was generally higher among fish held in illuminated cages than those reared in dark cages (67%). Low feeding of fish held in dark cages eventually led to starvation and mass mortality. The present results indicated that a light intensity of at least 300 lx attracts the highest number of zooplankton and promotes the best weight specific growth rate (10% day^{-1}) and survival (40%) in sea bass juveniles reared in illuminated nursery cages.

Madrones-Ladja AJ. 1997. Notes on the induced spawning, embryonic and larval development of the window-pane shell, *Placuna placenta* (Linnaeus, 1758), in the laboratory. Aquaculture 157: 137-146 --

Intragonadal injection of 0.5 ml of a 2-mM serotonin solution or seawater irradiated by ultraviolet (UV) light (925-1395 mW h/l) induced spawning in male and female window-pane shell, *Placuna placenta* (Linnaeus, 1758). Generally, mature shells spawned 15-30 min after serotonin injection or 30-60 min after exposure to UV light-irradiated seawater. The average number of eggs released per female were 1.57 x 10^6 and 1.24 x 10^6, for serotonin and UV light-irradiated seawater, respectively. The method using UV light-irradiated seawater is simpler to perform than serotonin injection into the gonads and can be applied to both individual- and mass-spawning experiments. Spawned eggs averaged 56 ± mm in diameter and fertilization was 100% successful. After fertilization, the polar body formed after 15 min and trochophores were observed actively moving in 325 min. Embryonic development was completed in less than 6 h. Sraight-hinged veligers with mean shell length (SL) of 84 ±18 mm appeared in the cultures 18-20 h after fertilization. Fed daily with microalgae *Isoschrysis galbana* (Parke), the larvae developed to early umbo on the second day of culture when SL was 103 ± 17 mm, while late-umbonal veligers of SL 145 ± 21 µm appeared on the seventh day. Crawling pediveligers were observed on day 9 when SL reached 205 ± 15 um. Newly metamorphosed larvae appeared on the 14th day when SL of 238 ± 9 um was reached. The survival rate at metamorphosis was 13%. The duration of the planktonic larval stages of *P. placenta* was about 14 d.





Update on milkfish PART 2 OF 4

Economic value of the milkfish industry

By Teodora Bagarinao, PhD
AQD Scientist

Fish, fishing, and fish farming are very important to the diet, culture, and economy of the people of the Philippines. The milkfish *Chanos chanos* (Forsskal) is so much a part of the way of life that it is the official national fish, as every school child is taught. Milkfish farming started about four centuries ago in the Philippines, the technology apparently having spread from Indonesia. Today, milkfish aquaculture in the Philippines is at a crossroad. Milkfish production has fluctuated sharply between 150 and 250 thousand metric tons, but on average has relatively stagnated over the past decade, partly due to the shrimp boom and the low price of milkfish. But now there is pressure to return to and intensify milkfish farming. Many shrimp farmers want to recoup losses by going back to milkfish and growing it for the export market. But more significant is the rapidly expanding domestic market. The population of the Philippines is already 70 million in 1996, up from 37 million in 1970, and now requires about 3.1 million metric tons of fish. Some 2.74 million metric tons were produced in 1995, but of these, more than half a million metric tons were seaweeds (not eaten), oysters and mussels (mostly shell weight), and snails fit only for duck food. There is now a large deficit in the fish supply and a concerted effort must be made to reduce the shortfall. Milkfish has been and will continue to be an important part of the fish supply in the Philippines.

Dr. Bagarinao is a marine biologist on AQD's milkfish R&D team.

The Philippines ranks among the top twelve largest fish producers in the world. The total fish production grew about 1.5% each year during the last five years and reached 2,740,032 mt valued at P83.9 billion in 1995. Aquaculture made up 30% of the volume of the 1995 production and accounted for nearly 40% of the total value. Over the past 20 years, the relative importance of milkfish has declined with the expansion of the farming of tilapia, tiger shrimp, and seaweeds (Fig. 1). In 1975, some 141,461 mt of milkfish, the whole of aquaculture, made up 10.6% of total fish production. In 1995, the total milkfish harvest of 150,858 mt made up only 5.5% of the total fish production and just 18% of the aquaculture production, one-third as much as seaweeds, and twice as much as tilapia. Production from brackishwater ponds used to be all milkfish in the early 1970s, but the share of milkfish came down to 78% in 1985 and only 58% in 1995.

The total milkfish production increased at an average rate of 22% a year in 1977-1981 (Fig. 2). The Fishery Industry Development Council optimistically projected a continued increase at the same rate to a total supply of 419,095 mt from ponds and pens in 1990. The Council also projected a Filipino population of only 58 million in 1990, a total milkfish demand of only 147,000 mt, and thus a large milkfish surplus every year. These projections turned out wrong as production fluctuated sharply between 150 and 250 thousand metric tons over the past 15 years (Fig. 2). The annual per capita supply of milkfish increased from 2.6 kg in 1970 to 4.8 kg in

FIGURE 1

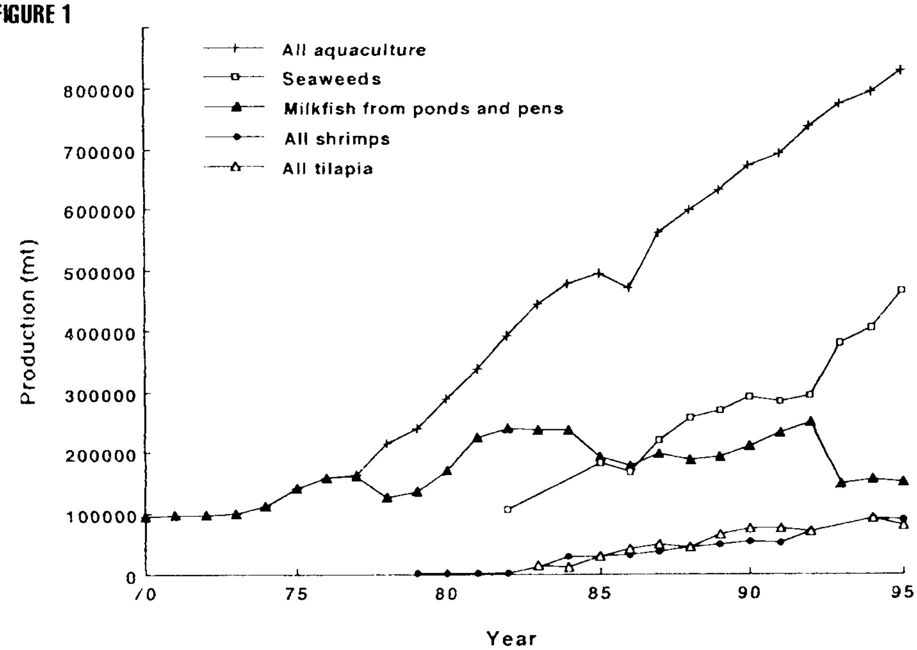
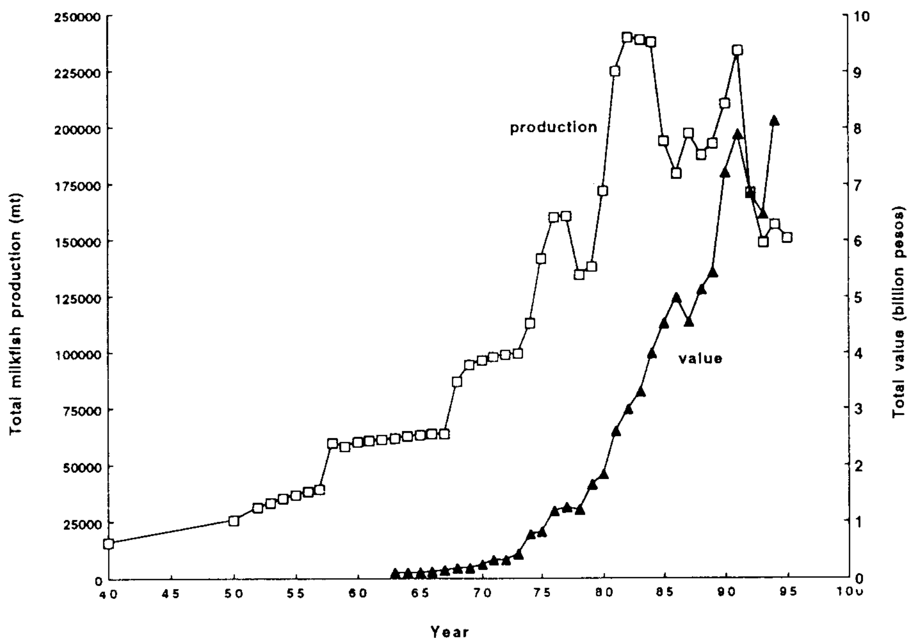


FIGURE 2



1982, but has since decreased to 3.4 kg in 1990 and 2.2 kg in 1995.

The milkfish production of 99,600 mt in 1973 was worth P434 million. Over the years, the value increased more than 18-fold to P7.88 billion in 1991, although the volume increased only 2.5-fold (Fig. 2). As production fell in 1992-93, the industry made only P6.5-6.8 billion a year. Fortunately, milkfish prices increased and the low production in 1994 was valued at more than P8 billion.

Milkfish 200-300 g are harvested and marketed mostly fresh or chilled, whole or deboned, but some are canned or smoked. The domestic markets, especially in Metro Manila, absorb most of the production. Milkfish are a first-class fish, less affordable to the lower income consumers, but important to all Filipinos on festive occasions. A single 200-250 gram milkfish used to cost P2-3 when the minimum wage was only P14-18 a day. Wholesale prices increased from P10/kg in 1981 to P56/kg in 1994, whereas retail prices rose from P12/kg to P67/kg during the same period. At present, milkfish sell at P60-120/kg retail, depending on the fish size and the market location. Local demand has also increased for deboned milkfish, even as these cost about 50% higher.

Milkfish is also exported in different product forms: frozen, dried, canned, smoked, or marinated. The milkfish export rose from 38 mt of frozen fish valued at P106,000 in 1969 to a peak in 1986 but declined to 869 mt worth P65.5 million in 1990. Frozen fish made up about 95% of the total exports; and 84% of the exports went to the USA. In 1995, milkfish exports amounted to 1,068 mt valued at P188 million. An export market for quick-frozen deboned milkfish fillets has begun to develop and fish processing companies are responding fast. Indeed, for intensive milkfish farming to be both profitable and sustainable, more value-added milkfish products must be developed and marketed.

The milkfish farming industry has important linkages with the various sectors that supply the inputs, and those that transport, store, market, or process the harvest. The industries that manufacture and supply fertilizers, lime, other chemical inputs, as well as milkfish feeds have not been studied nor valued in the context of milkfish aquaculture. Only the seed supply in terms of the fishery for milkfish 'fry' has been valued at ₱ 57 million in 1976, but current assessments are lacking.

Philippine fisheries statistics yearbooks always give the employment figure for aquaculture as about a quarter-million people, from the assumption that one person is hired for each of the quarter-million hectares of ponds. But employment in the milkfish industry is not only in grow-out operations, but also in the many allied sectors: fry gathering and trade, hatcheries, nursery ponds, fertilizer and chemical supply, supply of construction materials and feed ingredients, feed manufacture, transport and storage, post-harvest processing, marketing and trade, as well as in financing, research and development, and training and extension.

Literature citations are given in full in the original paper entitled *Historical and recent trends in milkfish farming in the Philippines*. In press. IN: SS de Silva (ed) Tropical Mariculture. Academic Press, London.

NEXT ISSUE

Milkfish fry supply from the wild
By TU Bagarinao
Milkfish broodstock development in the Philippines By Dr. AC Emata

Knowing Asian aquaculture and fisheries

By MB Surtida

Asia has always been the hub of aquaculture. For 300 centuries, fish have been farmed in China, and eventually through the region. Today, as demand for food grows proportionately with the population (30.1% of world population live in Asia), aquaculture is a logical option.

The following article gives a bird's eye view of aquaculture and fisheries in Asia. Hopefully, it will be useful to students whose work can influence laws, rules, policy, and regulations on aquaculture and fisheries, with the view in mind to sustainable aquaculture.

CHINA

Mainland China covers nearly 40% of latitude, thus climates vary widely - tropical, subtropical, temperate, cool-temperate. It has 18,400 km of mainland coastline and 14,200 km island coastline with 1.3 million hectares of cultivable shallow water and mudflat. It has three big rivers, Yantze, Yellow, and Pearl. China has 20 million ha of inland water of which 30% are under cultivation. In 1996, yield of aquatic products was 32.88 million tons. Of this total, fishing takes 43% and aquaculture, 57%.

China's population is 1.2 billion with the inland northwest areas sparsely populated.

Aquaculture

China has developed its freshwater aquaculture for more than 3,000 years. It is the first country to have succeeded in the artificial propagation of silver, bighead, grass, and black carps. It has also improved its techniques for the artificial propagation of other species. In recent years, China's mariculture has risen rapidly, the mariculture area increased to 822,070 ha in 1996, up from 365,000 ha in 1986 and the total mariculture production reached 4.32 million tons.

Yield of aquatic products in 1996 (x 1,000 tons)

Inland farming	10,989.5	33%
Inland fishing	1,762.9	5%
Marine farming	7,639.0	23%
Marine fishing	12,489.8	39%
Total yield	32,881.2	100%

Output of marine aquaculture (x 1,000 tons)

	1978	1994	1996
Crustacean	0.45	92.00	204.60
Fish	1.73	101.10	823.50
Seaweeds	191.49	730.10	929.11
Shellfish	255.83	2522.80	8526.75

Problems of the aquaculture and fisheries industry

Inadaptability of science and technology to rapid fisheries development. China considers fishery technical extension very important. In the whole country, there are over 5,000 fishery technical extension organization with technical staff of 17,000. But very few of these staff work at fishfarms. Thus, new techniques and achievements are not extended to most farmers.

There is a shortage of personnel from secondary technical schools at most fishfarms. Student proportion of universities/colleges to secondary technical schools is 4:3.

Enviromental protection. A huge quantity of untreated wastes becomes a serious problem in fisheries. Factories discharge a lot of sewage and industrial wastes into rivers and coastal areas. For example, shrimp culture yield in China dropped from first place (global) with annual yield of 220,000 tons in 1992 to 60,000 tons in the last years. Farms suffered heavy losses due to shrimp diseases.

Marine fishes are caught excessively. It may appear that output has increased steadily over the years but this is due to the increasing number of fishing vessels, gears, and intensified fishing of coastal and inshore resources. It is not due to increased productivity of the sea.

INDONESIA

The islands and part of islands that form Indonesia cover 1,919,443 km². At least 3,000 of the country's 13,667 islands are inhabited, with a population of 200 million people. Indonesia is tropical, daily temperature fluctuates between 21- 32°C.

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Coastal aquaculture

In 1985, total fisheries production was about 2.4 tons and rose to about 4.0 tons in 1994. Brackishwater pond production was 156,400 tons in 1985; 346,200 tons in 1994, and annually increased by 9.4%. Cage culture production increased annually by 70.6% from 746 tons in 1985 to 33,011 tons in 1994.

Brackishwater culture

Brackishwater pond production was 156,367 tons in 1985 and 346,214 tons in 1994, increasing annually by 9.42%. Milkfish and shrimps were the species mainly produced, their contributions were 44.22% and 38.24% of total production.

Brackishwater fish culture production came from East Java 23.87%, South Sulawesi 21.50%, West Java, 19.96%, and Central Java 10.40%. Total production was 262,190 tons or 75.73% of total brackishwater fish culture production (346,214 tons).

Molluscs of economic importance include the cockle *Andara granossa* (19,400 ha); the mussel *Mytilus viridis* (19,700 ha); oyster (7,500 ha); and pearl oyster (2,200 ha).

Seaweed culture

There are 355 collected seaweed species from Indonesia waters. About 55 species of them have been utilized by Indonesians as food (salad, vegetable, and soup thickening) and medicinal treatments. The total area planted to seaweeds is 21,000 ha.

Constraints

With Indonesia's industrialization, many industries have been established in watershed and coastal areas. Some of these industries dump toxic waste, endangering the carrying capacity of coastal waters to support coastal aquaculture in some areas. The uncontrolled development of industries neglect the regulations concerning the green belt in coastal areas, thus destroying the nursery grounds of the marine biota.

BANGLADESH

Bangladesh is a tropical country in the south coast of Asia. It is surrounded by India, Myanmar, and the Bay of Bengal. Bangladesh has four distinct seasons: summer, rainy, winter, and spring with 125 km sea beach and 960 km-long coastal belt. The river Karnofuly has 68,800 ha with an annual fish production of 50,000 t.

Bangladesh consists of 80% plane land, 8% hilly areas, and 7% coastal belts.

Bangladesh is the ninth largest country in the world in terms of population. Its total area is 148, 393 km^2 with a total population of 124 million, approximately 900 persons per km^2. About 79% of the population live in the rural areas and 21% in the urban areas. Population growth rate is 2.2% with a literacy rate of 36.6%.

Status of fisheries

The fisheries sector provides almost 4.7% of the national income and 14% from the agricultural sector. Almost 11.2 million people work permanently and temporarily in the fisheries sector, about 10% of the total population directly or indirectly involve themselves in fisheries.

Fisheries contribute 10% of total export of Bangladesh ($482.84 million in 1995-1996). Fish and fisheries products is its third exportable item.

Of the country's total area, 9380 km^2 are rivers; 0.29 million are closed waters (lakes); and 0.14 million are coastal shrimp farms. Bangladesh has 716 km of coastline.

There are 260 indigenous and 12 exotic species of shrimps cultured in inland Bangladesh. In ocean areas (Bay of Bengal), 495 species of fish and 36 species of shrimps have been identified. The area of marine water bodies of Bangladesh is 164 km^2. Twenty-two percent of total catch comes from marine water bodies.

Production

Inland aquaculture has produced 390,000 tons of common, grass, silver carps; catfishes, and other fishes in 1995-1996. This is valued at US$ 6.82 million. In contrast, marine fish catch -- mullet, shrimp, etc -- amounted to 279,000 tons valued at US$3.48 million while inland catch fishery -- catfish, carp, tilapia, etc -- amounted to over 0.5 million tons valued at US$ 1 billion.

Marine fisheries resources management

Trawler fisheries contribute 95% of the total harvested marine fishes. This is regulated by the government.

It has been recognized that the total stocks in marine water bodies are not limited. To maintain equilibrium, the number of trawlers have been fixed and mesh size of the nets are controlled. Marine surveys are being conducted for stock assessment, identification of new fishing grounds to determine the location of marine fishes like tuna and mackerel.

Artisanal fisheries include 3,317 mechanized and 114,000 ordinary boats. These are not yet regulated by the government.

Constraints

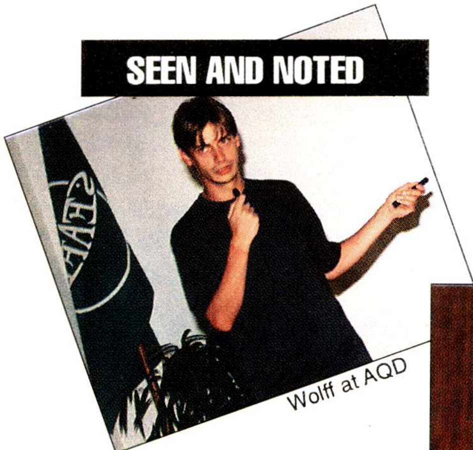
Fisheries production is not sufficient to meet demand of the increasing population with a low literacy rate. In rural Bangladesh, there are many derelict ponds which are not reconstructed for fish culture. But rural illiterate people do not know how to culture fish, thus, inland open fisheries and marine areas are over exploited. Now, fishery extension workers are working and motivating farmers to make use of these resources.

List of references will be provided upon request. - Ed.

NEXT ISSUE

Cambodia, India, and Myanmar

SEEN AND NOTED



Wolff at AQD

Starting this year, we are featuring the seminar presentors at AQD -- visiting scientists and guests -- as they share new ideas and new experiences from around the world.

Fish migration and some general aspects about fishways in middle Europe. This is the new year's first research seminar presented 22 January at AQD. The speaker, **Gunnar Wolff**, is a fisheries engineer with the Federal Institute for Food and Agriculture, Hamburg, Germany, and is on a study-vacation in the Philippines from 14 January to 4 February 1998.

What was the seminar all about? Here's the summary:

Some fishes migrate from the sea to freshwaters/rivers as part of their life history. For instance, the salmon need to go back to its "birth river" to spawn. But dams constructed in rivers are often steep, and these obstruct the fishes' upstream journey. The solution is man-made fishways, structures that bypass the dam.

Fisheries experts have already studied the engineering of fishways. Wolff said a fishway can be a natural bypass, having an inclining slope of 1-2%; a fish ramp (4-5% slope); conventional steppass and vertical slot pass (8-10%); or denil pass (17-20%). The entrances of these passes must be close to the turbulence zone (foot of the dam), among other requirements. The exits will be at some upstream distance from the head of the dam. - MTC

Approach to environment improvement by using bacteria (bioremediation). This seminar was presented by **Dr. Isao Sugahara**, the incoming Vice President of Mie University (Japan) on 30 January. Dr.

Dr. Sugahara

Sugahara concentrates on environmental microbiology particularly wastewater treatment. He is visiting AQD. His seminar zeroed in on the use of bacteria to reduce organic matter and nitrogen-phosphorus levels for the purpose of improving the (aquaculture) environment. He noted that prawn culture pollutes the water and the sediment through overfeeding, non-stop production, and the use of antibiotics. This pollution worsens the pond environment (oxygen is depleted, pH changes). Prawn lose its health, the farm suffers a disease outbreak,

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SEAFDEC Secretary-General Udom Bhatiyasevi welcomed AQD Deputy Chief Yasuho Tadokoro on-board M/V SEAFDEC for the short cruise from Samut Prakan to Pattaya, south of Bangkok. Mr. Tadokoro joined the SEAFDEC Council Directors and other dignitaries in the cruise.

The SEAFDEC family: 30 years and counting

For 30 years, SEAFDEC has kept a relatively low profile while building technical expertise in four areas of fisheries development: marine capture fisheries, fisheries post-harvest technology, aquaculture technologies, and recently, marine resource development and management.

So, when SEAFDEC turned 30 last December 1998, the celebration in Bangkok to mark this important milestone was also subdued but meaningful. On Decem-

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Thailand's Minister of Agriculture and Cooperatives Mr. Pongpol Adireksarn, the Guest of Honor during the anniversary gala dinner, was greeted by AQD Chief Dr. Rolando Platon (right, in white) and other SEAFDEC officials.

The Minister stopped briefly at the AQD poster presentation.

WORDWATCH

HAPPY AS A CLAM Actually the whole phrase should be "happy as a clam at high tide," meaning, you're pleased with things.

At high tide, water covers the mud flats where clams live. That makes clams safe from clam diggers, who dig clams only at low tide.

- National Geographic, May 1988

•NEW SUBSCRIPTION RATE•

Dear readers,

With much regret, we are raising the price of this publication beginning 1998. The old price of P100 or US$30 per six issues can not cover the cost of color printing and of mailing.

This newsletter now costs P300 in the Philippines and US$40 elsewhere per six issues. Our 1997 subscribers and our publication exchange partners will not be affected.

Editorial staff

Sugahara seminar ... from page 9

and the farmer gets a low production. The outflow of polluted water (which is rich in organic matter, nitrogen and phosphorus) flows into the coastal areas (though some will be taken up by mangroves and mangrove-associated organisms), and results in eutrophication and red tide outbreaks. Production in coastal areas become low.

To counter environmental pollution in aquaculture, Dr. Sugahara set-up a microbial system in the laboratory using denitrifying bacteria, ammonia-oxidizing bacteria, and microalgae which were isolated from a sea bream farm in Nishiki Bay of Japan. These bacteria were attached on and into ceramic beads (which serves as microbial carrier) which were then spread on the bottom of the sea bream farm.

Dr. Sugahara noted that the bottom mud contains markedly less organic matter after the spread of the beads. Total nitrogen also decreased. Several types of bacteria were observed but there was no significant difference in their numbers.

The effects of bioremediation appear to be higher in summer than in winter. Bioremediation in winter is only 30-50% effective.

In conclusion, Dr. Sugahara says, environment improvement or control by useful functions will have a practical use not only in aquaculture but also in environmental science. - MBS

SEAFDEC at 30 ... from page 9

ber 8, SEAFDEC arranged a short cruise of its research and training vessel, the MV SEAFDEC, for its Council Directors and dignitaries from Member-Countries. Then, an open meeting was convened to discuss the views of fisheries experts on the direction of SEAFDEC programs. A strategic planning session was conducted the next day. The *20th Meeting of the SEAFDEC Program Committee* followed the anniversary celebration.

SEAFDEC Secretary-General Udom Bhatiyasevi noted that "SEAFDEC needs to employ a cost-effective strategy particularly at the time of financial constraint experienced by the Center ... The changes in global and regional scenes would necessitate a program redefinition to sustain (SEAFDEC's) operation into the next millennium."

With 30 years of solid accomplishments behind it, SEAFDEC plans to increase involvement in **regionally important issues** like trade and environment concerns to have a more proactive stand. Appreciation has already been expressed regarding SEAFDEC's programs on turtle excluder device and breeding coral reef fishes in captivity. More work on mangrove conservation, antibiotic residues, dolphin protection, shark fisheries, to name a few, has been suggested. These are aspects of responsible fishing and sustainable aquaculture practices.

Another plan is **greater cooperation and collaboration** among SEAFDEC Member Countries especially on fisheries resource assessment (tuna, squid, marine turtle, among others) and on training. Closer cooperation with ASEAN will be sought, as SEAFDEC is expected to cooperate with non-member countries in the region. More participation of the private sector will be sought as well, as with international and regional organizations.

SEAFDEC also plans to attain **higher visibility** of its programs in the next few years. For one, it plans to link all its departments -- in Thailand, Singapore, the Philippines, Malaysia -- into an information network accessible through the Internet. Information dissemination for resource conservation will be a primary consideration. - APS / MTC

Seaweed culture

Seaweed longlines in rivers
(*Gracilariopsis*)

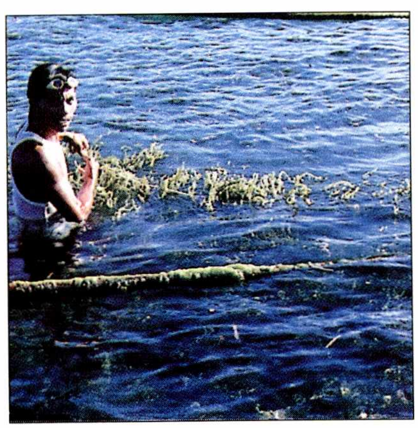
"Rice-planting" method in canals
(*Gracilariopsis*)

Seaweed culture is a good thing. First, capitalization is less than any other aquaculture species (for example, ₱20,000 per hectare for *Kappaphycus*). Second, seaweed culture does not need inputs that are potentially harmful to the environment. Third, seaweed farms are not labor-intensive. Fourth, the market for seaweed extracts -- agar, alginate and carrageenan -- are diversified (food, pharmaceutical, and other industrial sectors).

Some seaweed species are being farmed like the carrageenan-bearing *Kappaphycus* and the agar-bearing *Gracilaria*. These can be cultured in ponds, canals, rivers, tidal flats, and the open sea by fixed bottom longline, hanging longline, "rice planting" method, cages, and rafts.

In this special feature for aquaculturists, we present a few facts about the world seaweed industry, markets in southeast Asia, and some specifics of the Philippine industry. Also included are: culture techniques for *Kappaphycus* and *Gracilaria* especially touching on AQD research and development, a village level processing technique for extracting agar, and the uses / applications of seaweed extracts.

Pond culture (*Gracilariopsis*)

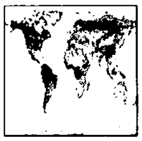


Raft culture (*Kappaphycus*)

Experimental tank culture
(*Kappaphycus*)

PHOTOS COURTESY OF
AQD SEAWEED TEAM

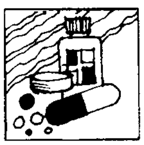
THE SEAWEED INDUSTRY AT A GLANCE



WORLD PRODUCTION

- about 6 million tons in 1995, mostly the brown seaweed variety, followed by reds and greens
- about 90% came from the Asia-Pacific

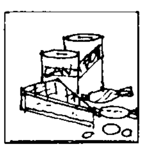
SEAWEED PRODUCTS



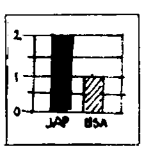
AGAR, ALGINATE and CARRAGEENAN are extracted from seaweeds and then used in textiles; pharmaceuticals, processed food; media for medical, industrial, microbiological preparation, and horticultural applications in tissue and cell culture

CULTURE SPECIES

THE RED SEAWEED *GRACILARIA* is the most common source of agar. It is cultivated in Chile, China, Taiwan, and Indonesia; about 1.5-4.3 tons of dried seaweed are produced per ha per year.



AGAR PRODUCTION
Estimated world production was 7,000-10,000 tons valued at US$ 200 million in 1989.



Japan is the major consumer (about 2,000 tons per year) mostly coming from domestic production. USA consumes 1,000 tons per year which is mostly supplied (80%) by Chile, Morocco and Spain. The European Union needs about 1,300 tons per year.

MARKETED FORMS OF AGAR
seaweed powder
direct or treated seaweed strips, flakes
granular agar

THE BROWN SEAWEEDS ARE SOURCES OF ALGINATE. China, Korea and Japan cultivate the browns for food, not for algin.

The US gets its alginate from kelp harvested from the wild in California. Mexico produces some, but the El Nino phenomenon adversely affects production.

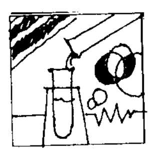
Alginate has various industrial applications. Europe gets the biggest share of the world total production. There are two processing plants in Europe and one in the US.

CARRAGEENAN MAY BE EXTRACTED FROM *Kappaphycus* and *Eucheuma* which are cultured in the Philippines, Indonesia, Fiji, Micronesia and China.

Other sources of carrageenan are *Chondrus* and *Gigartina* which are abundant in Canada and the Atlantic coasts of Europe.

THREE TYPES OF CARAGEENAN USED COMMERCIALLY
(1) **kappa carrageenan** - a hard-gelling colloid extracted from *Kappaphycus* among others
(2) **iota carrageenan** - a soft gelling colloid from *Eucheuma* among others
(3) **lambda carrageenan** - a non-gelling colloid extracted from *Kappaphycus*

The carrageenan industry showed a 4% yearly growth from 1978 to 1993. The five major carrageenan markets are Europe (36%), North America (26%), Latin America (17%), Australia (13%), and Japan (8%).



RESEARCH AND DEVELOPMENT

The search for new species with economic potential and R&D on applications of hydrocolloids are continuously pursued. Each seaweed-producing country has its own R&D program (see also page 19 for AQD's research priorities on seaweeds.)
- **EA / MTC / ETL**

(Excerpted from the article of AQD Senior Scientist Dr.

The Philippine Seaweed Industry

Anicia Hurtado-Ponce that appeared in the Assessment Reports - (Philippine) Export Winners *published by the Department of Science and Technology in collaboration with United Nations Development Programme, 1997)*

The Philippines is one of the major producers of the red seaweed *Kappaphycus alvarezii (*also known as the *cottonii* type) which is a source of the semi-refined or Philippine natural grade (PNG) carrageenan. The shortage of locust bean gum (used in pet food) gave PNG a place in the world market in 1994. Europe's acceptance of PNG as food additive was significant, increasing the number of buyers that already included the US, Japan, Latin America, other Asian countries and Canada.

PNG is also being used in the meat-poultry processing and personal care (toothpaste) industries. Likewise, the interest of pharmaceutical industries in PNG may further increase demand for *Kappaphycus* and *Eucheuma.*

OPPORTUNITES AND THREATS

PNG had to go through a stringent test in the US and Japan before it gained acceptance in the world market. The quality of PNG has to be maintained.

Indonesia, which expanded its *Kappaphycus* and *Eucheuma* culture, is the Philippines' strongest competitor.

Another threat to the industry is the deteriorating quality of *Kappaphycus* seedlings.

STRENGTHS

Alternative species

Other than *Kappaphycus*, the industry can culture and market the following species: *Gracilaria changii, G. firma, G. heteroclada (=Gracilariopsis bailinae), G. manilaensis* and *G. tenuistipitata.* These have been identified by R&D institutions as good sources of (bacteriological) agar and agarose which would beacon the rise of *Gracilaria* industry.

It is also commercially viable to farm *G. heteroclada* in estuarines and in ponds as shown by AQD. There is also the potential of using *G. heteroclada* as biofilter in intensive shrimp farms.

Processing

The number of processing plants and refineries reflects the strength of the industry. The Philippines has the largest carrageenan refinery in Asia and one of the best in the world. This gives the country an edge over other producers. At present, there are three commercial agar processing plants in Luzon operating seasonally during peak months of *Gracilaria* harvest (January-June).

WEAKNESSES

Production of seaweeds, however, is seen as erratic, and this is attributed to (1) indiscriminate harvesting, seasonal abundance of different species in different areas, and lack of proper management especially for *Gracilaria*; (2) shortage and deteriorating quality of seedlings especially for *Kappaphycus*; and (3) natural calamities.

Some recommendations for the industry's problems are tabulated below:

Species / Problem	*Recommendations*
GRACILARIA	
Erratic and seasonal supply of natural stock	Inventory, assessment and management of natural stock
Outdated agar processing plants	Upgrading of facilities
KAPPAPHYCUS	
Poor quality of seedlings	Strain selection; establishment of seedling bank; out-planting of selected seedstocks
Decrease biomass of harvested crops	Improvement of seedstock quality; optimization of biomass production; expansion of farming areas; improvement of farming techniques
Poor quality of harvested crop	Proper drying and storage facilities; ecological physiological evaluation of stock
"Ice-ice" phenomenon due to disease and environmental degradation	Proper farming practices
SARGASSUM	
Depletion of natural stock	Resource management; transplantation; spore recruitment
Absence of alginate processing plant	Establishment of pilot alginate processing plant; manpower development
IN GENERAL	
Lack of funds for expansion / upgrading to produce quantity and quality colloid	Linkage with government financing institutions
Limited product applications of carrageenan, agar & alginate	Development of new applications through R&D
Limited market information	Strong links between SIAP, DTI consular offices
Lack of skilled personnel	Degree and non-degree training programs

- EA / MTC

Farming techniques for seaweeds

By **M Castaños** and **R Buendia**
Photos courtesy of the AQD seaweed team

Farmers could earn more from seaweed culture than from milkfish, mud crab, tiger shrimp or tiger shrimp-tilapia culture. The economics of these systems have been computed by AQD researchers as follows:

Species cultured	Total investment (ha)	Net income (per ha per yr)	Return on investment (%)	Payback period (yr)
Kappaphycus	18,750	187,896	1,003	0.10
Milkfish	18,688	14,694	79	1.10
Mud crab	88,201	58,585	66	1.17
Tiger shrimp	32,906	11,686	36	2.10
Tiger shrimp + tilapia	34,024	23,697	70	1.20

With a good carrageenan market worldwide, farmers could not go wrong on *Kappaphycus* and other seaweeds.

BOTTOM LINE CULTURE METHOD FOR *KAPPAPHYCUS*

The fixed off-bottom monoline or bottom line method of cultivation is commonly used in commercial farms. This is due to lower cost of materials, labor and maintenance; higher net income and return of investment; and shorter payback period as compared to the net, raft monoline and hanging longline methods.

Here's how bottom line culture is done:

1 CHOOSE A GOOD SITE

Kappaphycus farming areas usually have moderate water movement, sandy to corally bottom, far from river mouths and protected against destructive waves.

Clear the chosen site of undesirable organisms.

2 CONSTRUCT THE MONOLINES

Stake wooden anchors into the substratum (like mangrove branches), about 6-10 meters apart. Tie in the nylon lines (see illustration).

Distance of the rows of stakes is 1 m apart. The nylon lines is 0.3-0.5 m away from the bottom depending on water depth during low tide.

3 SEEDLINGS AND FARM MAINTENANCE

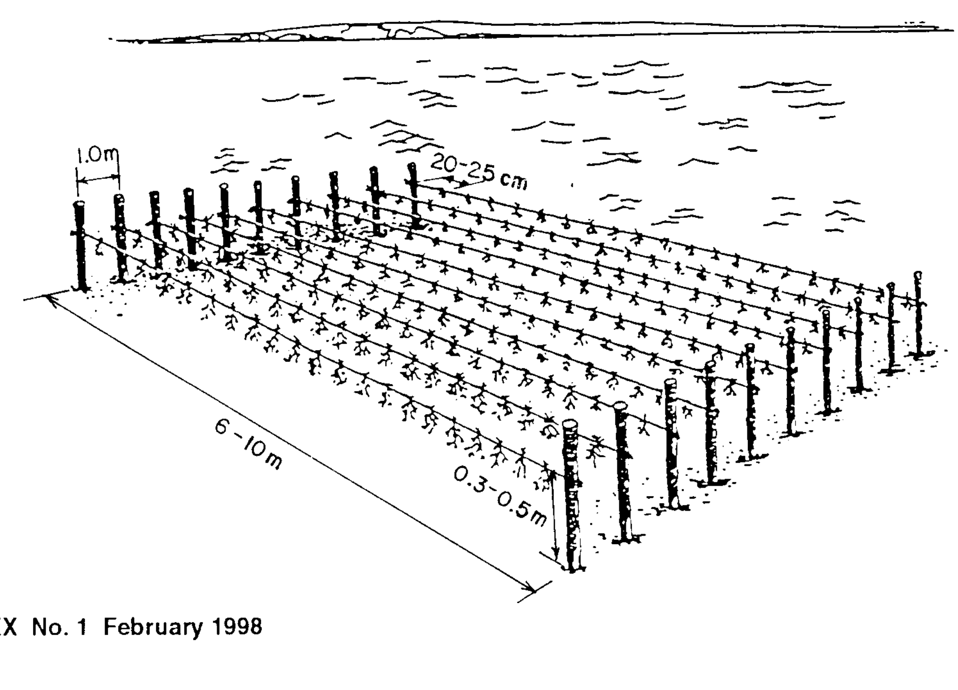
Tie the *Kappaphycus* seedlings or cuttings to the nylon at 20-25 cm intervals using soft plastic materials. Replace poorly growing and lost seedlings, and remove grazers such as sea urchins and starfishes and epiphytes growing on seaweed as these compete for nutrients, light and space.

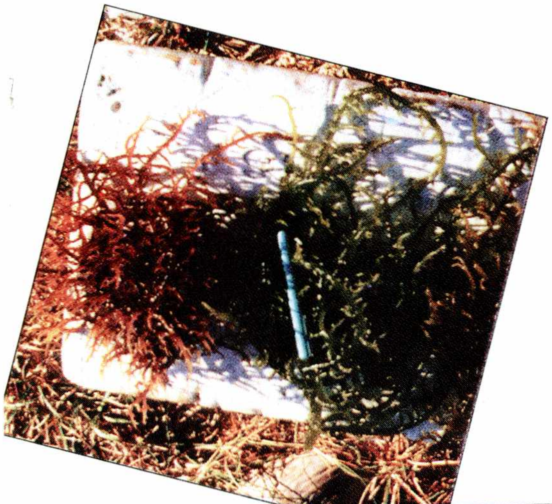
4 HARVEST AND OTHER NOTES

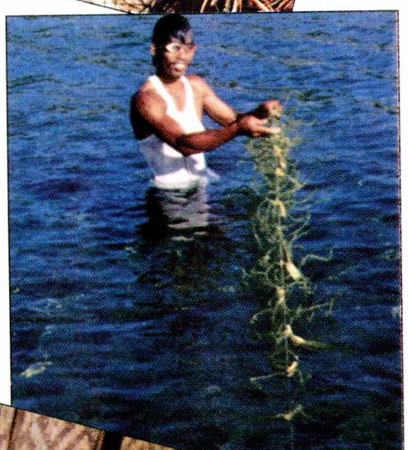
Harvest after 2-3 months. Take the whole plants but leave enough for the replanting of new cuttings. Sun-dry seaweeds before selling to processors. Pack in sacks.

As noted on the table above, net income and return-on-investment is

Fixed off-bottom monoline method of farming Kappaphycus *(from Trono 1994). Not drawn to scale.*







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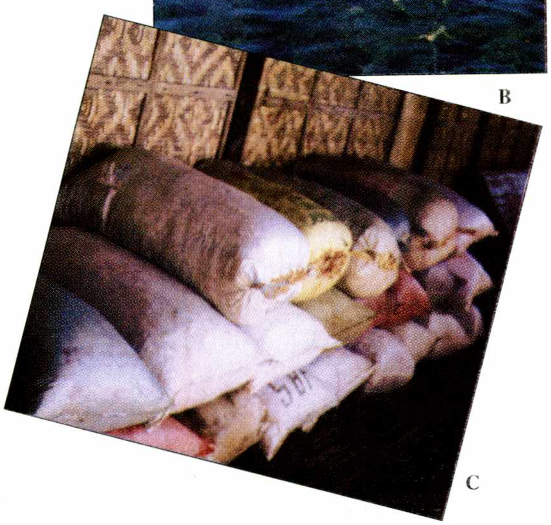


C

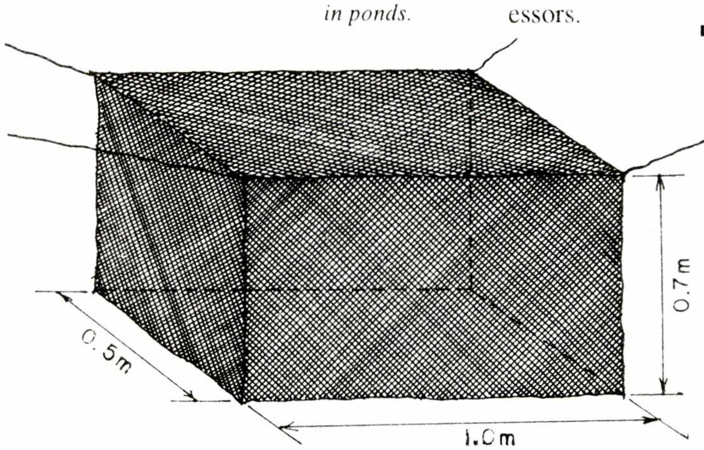
better than other culture species. These can be gained from a total investment and working capital of only ₱18,750, mostly the cost of monoline ropes, posts, and non-motorized banca. Succeeding crops will need a little over ₱5,000 for operating expenses (labor for seeding and plastic strips).

(These estimates were computed in 1995 based on seaweed farms in Panagatan Cays, Antique. - Ed.)

POND CULTURE OF *GRACILARIA*

The agar-rich *Gracilaria* can be cultivated in ponds and in canals. The industry method is similar to planting rice where seaweed cuttings are directly staked onto the bottom. AQD, however, modified this practice by using a hapa net in growing *Gracilaria* in brackishwater ponds (see illustration). These modifications are expected to reduce the amount of grazing by fishes (like tilapia) that are not totally eradicated during pond preparation. These also make harvesting and checking the stock easier.

Hapa nets may be used in Gracilaria *culture in ponds.*



1 USE EXISTING OR IDLE BRACKISHWATER POND

Drain the pond, clear it of unwanted plants and debris, and sun-dry. Apply lime only if it is necessary. Let in water, and maintain at 60-80 cm throughout the culture period.

2 INSTALL THE HAPA NET

Install the hapa net (1 x 0.5 x 0.7 m and 5 mm mesh, illustration below) with the bottom embedded in the pond. Sixteen hapa nets may be used per 200 m^2 pond.

Evenly distribute young *Gracilaria* fronds or vegetative fragments (10-15 cm long). Use about 200-250 grams of these fronds per hapa net.

3 TAKE CARE OF THE STOCK HARVEST

Change water following the tidal cycle. Fertilize the pond every two weeks using 3 kg per ha of urea.

Clean the hapa nets regularly. Scoop out any *lab-lab* that floats to the surface.

Gracilaria may be harvested after 45-60 days of culture. Like *Kappaphycus*, dry the *Gracilaria* before packing and selling to agar processors.

page 16

FARMING TECHNIQUES FROM PREVIOUS PAGE ...

AQD researchers have also tried the use of netcages in a protected cove to culture *Gracilaria*. The netcage has the same advantage as the hapa net: it reduces grazing. AQD researchers have noted that about 25-75% of *Gracilaria* show grazing damage by siganid, parrotfish, and glassfish to name a few.

Polyculture of seaweed with fishes is also feasible, giving added income to fishfarmers while maximizing the use of the netcage. AQD researchers, however, caution that their results are still experimental and the economic feasibility of the netcage method will need more careful study.

The netcage design is shown below. The stocking density is the same as in hapa nets in ponds.

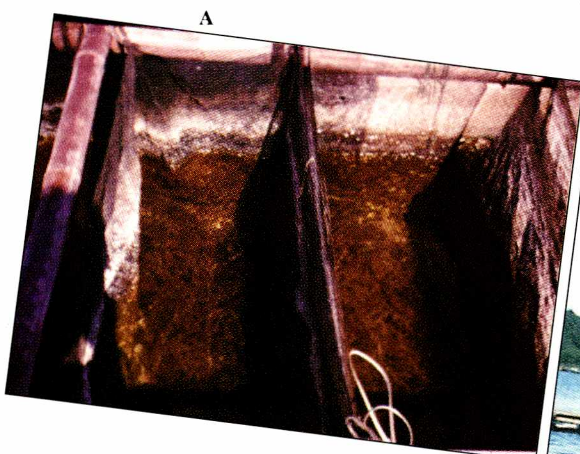
Gracilaria's rotten thallus syndrome

Like animals, plants do get sick and seaweed is no exception. A white to pinkish discoloration on the seaweed *Gracilaria* -- maintained in tanks -- is one sure sign of the gradual disintegration of the thallus. This syndrome, notes an AQD researcher, is associated with and may be caused by agar-digesting bacteria. A lot of these bacteria, some 1.42×10^7 bacterial cells, can be found per gram of affected thalli.

Based on biochemical tests, the bacterial isolates from *Gracilaria*'s rotten thalli have been classified as belonging to the genus *Vibrio*.

Diseases usually result from the interplay of the condition of the host (in this case, the seaweed), some ecological factors that can weaken its disease resistance (like reduced flow rate of water for tank-held seaweed stock), and the advantage that potential pathogens (like *Vibrio*) gain. The lesson for seaweed growers is to take extreme care in avoiding water pollution in their farms, and in being more active and more aware about environmental and sustainability issues in general. Seaweed farms are part of a coastal ecosystem that is affected by terrestrial ecosystems, too.

A



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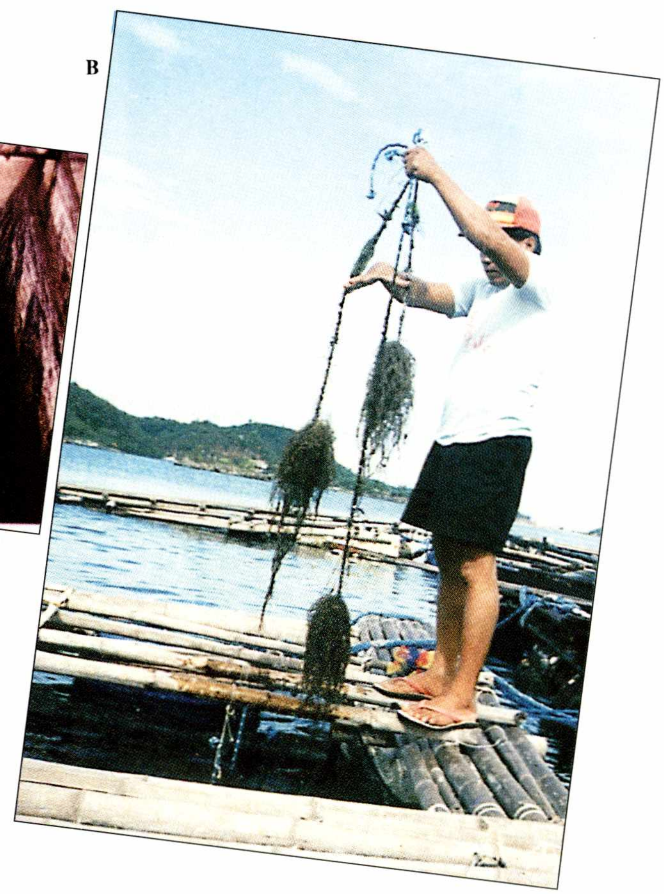
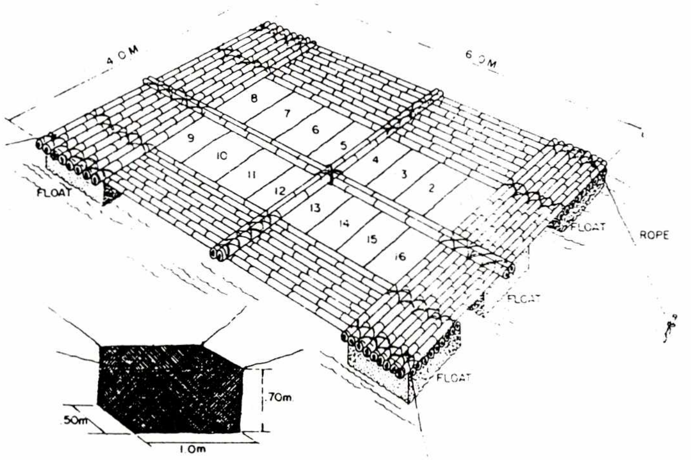


Netcage for Gracilaria *culture in the open sea. (A-B)* Gracilaria *cage culture at AQD's Igang Marine Substation.*



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BAILINAE, THE NEW SEAWEED ON THE BLOCK

AQD researchers have surveyed the seaweeds of Panay island in west central Philippines and they recorded 41 new seaweeds for Panay. One such record is *Gracilariopsis bailinae* (=*G. heteroclada*) which are found on protected bays, estuarines / rivers, and creeks with sandy-muddy substrate; and sometimes in brackishwater ponds.

AQD researchers proceeded to test the *rheological properties of agar extracted from *G. bailinae*. A 60-minute extraction produces agar gels with the highest breaking strength (1,013 g), the maximum cohesiveness (7.4 mm), the greatest breaking energy (7,481 g per mm), and the greatest stiffness (137.3 g per mm). Gelling temperature ranges 28-40°C and melting temperature 70-92°C. These values suggest a strong, firm and rigid gel. Strong gels are important because these are resilient, elastic, relatively transparent, relatively permanent, and thermo-reversible. *G. bailinae*'s gel may be used in bacteriology.

With this potential use in mind, AQD researchers assessed the investment requirements and production costs (tables on this page). A costs-and-returns analysis is found next page. Initial investment in a 0.1 ha farm is as little as ₱ 4,000 (computed in 1997) and the first crop costs ₱1,500. The next 8 crops would cost only ₱300. Return on investment is over 500% in 2 months.

Although the fixed bottom longline method is used in the financial analysis, commercial farms in Iloilo and Surigao use the "rice-planting" method which is a cheaper investment. The fixed bottom longline is still a demonstration project of BFAR-FAO-UNDP in Sorsogon.

☞ page 18

*rheology is the science dealing with deformation and flow of matter

Investment for a 0.1 hectare *Gracilariopsis bailinae* farm using the fixed-bottom longline method (from Hurtado-Ponce et al. 1997).

	Quantity	Unit cost	Total	Economic life (year)	Annual depreciation
Capital assets					
Drying platform (bamboo)	1 unit	₱ 1,000.00	1,000.00	2	500.00
Polyethylene rope (No.7)	4 rolls	70.00	280.00	5	56.00
Basins/pails (big)	1 pc	400.00	400.00	2	200.00
Subtotal			1,680.00		756.00
Working capital (first crop)			1,420.00		
Total investment			₱ 3,100.00		

Computed using the straight line method by dividing cost of asset by the economic life of asset. Value of the asset scrap is assumed to be zero.

Cost of *Gracilariopsis bailinae* cultivation using fixed bottom longline method (0.1 ha) (from Hurtado-Ponce et al. 1997)

	Quantity	Unit cost	Total
Production cost (first crop)			
Seed plants (kg)	500	₱ 2.00	1,000.00
Plastic tie-tie (rolls)	1	45.00	45.00
Mangrove posts (pcs)	240	0.50	120.00
Hired labor (man day)	3	60.00	180.00
Depreciation			75.00
Subtotal			1,420.00
Succeeding crops (2nd-9th crop)			
Plastic tie-tie (roll)	1	45.00	45.00
Hired labor (man-day)	3	60.00	180.00
Depreciation			75.00
			300.00
Subtotal (8 crops)			2,400.00
Annual production cost (9 crops)			3.820.00

Exclude opportunity cost of labor and capital

"Rice-planting" *G. bailinae*

Cost and returns from 0.1 hectare *Gracilariopsis bailinae* farm using fixed bottom longline method (from Hurtado-Ponce et al. 1997)

	Quantity	Unit price	Total
Seedling density (kg per 1,000 m²)	500		
Average yield (fresh weight, kg)*	2,220		
Less: seedling allocation (kg)	500		
Net yield (fresh, kg)	1,720		
Dry yield (20% moisture content, kg)	344	₱ 7	₱ 2,408.00
Net returns			
First crop			
Gross returns			2,408.00
Less production cost			1,420.00
Net returns for first crop			988.00
Succeeding crops (2nd to 9th crop)			
Gross returns			19,264.00
Less production costs			2,400.00
Net returns for the succeeding crops			16,864.00
Annual net returns 1000 m²			17,852.00
Return on investment (%)			575.87
Payback (years)			0.16

*at 4.5% average (specific) growth rate.

For *G. bailinae*, the tried and true "rice-planting" method can be used by seaweed growers. The following technique is drawn from the experiences of 8 *Gracilaria* growers in Panay who were interviewed by AQD researchers.

1 USE PONDS OR CANALS

Farm size can range 0.5 to 5 hectares for ponds and 825-7,055 m² for canals. Pond bottom should be sandy-muddy. Use *G. bailinae* found in the locality as seedstock.

2 "RICE-PLANT" THE SEEDLINGS

Start culture in June-July although a November-December start is also practiced. Cut the thalli into 15-20 cm or weigh in 15-20 g of seaweed. Stake this thalli bunch onto the pond or canal bottom. Allow for 10-15 cm space between the staked bunches.

3 STOCK MAINTENANCE HARVEST

Gracilaria are usually left alone, but change water if possible and keep the pond or canal clean of debris. Harvest after 45-60 days in the ponds or after 15-20 days in canals. But leave about one-third to serve as seedstock for the succeeding period.

Sun-dry the harvest for 2-3 days using old fish nets or bamboo slats. Pack in sacks and store in a cool, dry place. Growers may opt to accumulate a bigger volume to await a higher price.

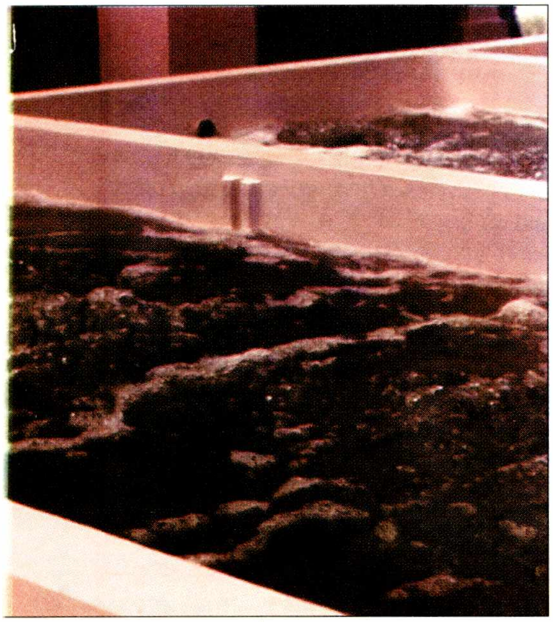
4 OTHER NOTES

Growers who plant in ponds can have 12-16 croppings in a year; in canals, 16-24. Ponds can produce 3-4 tons of dried seaweeds per ha per year or an average 450 kg per ha per crop. In canals, yields of 7-14 tons dried seaweeds per ha per year is attainable or an average 1.3 tons per ha per crop.

Initial investment for a 1-ha pond is about ₱16,000 (computed in 1992); in a 1-ha canal, ₱4,600. This covers pond development, drying platform, dug-out, non-motorized banca, and working capital for the first crop.

Investment for the second and succeeding crops costs about ₱1,500 for both pond and canal. This includes family labor, caretaker's salary, hired labor, marketing expenses, land tax, permit and depreciation.

Growers can get an income of ₱24,000 from ponds or ₱41,800 from canals (total of 8 crops).



Seaweed tanks at AQD's Tigbauan Main Station in Iloilo, west central Philippines

AQD's seaweed R&D priorities

Gracilaria species

- genetics and creation of seedbank
- monoculture and polyculture in ponds
- use as biofilter in semi-intensive and intensive shrimp ponds
- product utilization, eg. as feed ingredient
- village-level processing of agar
- socioeconomic studies in seaweed-dependent communities

Kappaphycus alvarezii

- genetic studies for strain selection
- development of seed production technology

Sargassum

- natural recruitment of spores using artificial concrete blocks
- transplantation of juvenile plants
- establishment of artificial *Sargassum* beds

PUBLICATIONS OF AQD RESEARCHERS ON SEAWEEDS (1990-PRESENT)

Chavoso EAJ, AQ Hurtado-Ponce. 1995. Effects of stocking density and nutrients on the growth and agar gel of *Gracilariopsis bailinae* (Gracilariales, Rhodophyta). The Philippine Scientist 32: 27-33.

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☞ page 25

Village level processing techniques

By **MB Surtida**

Agar bearing seaweeds *Gracilaria* spp. and *Gelidium* spp. grow abundantly in the Asia-Pacific region. They grow well in a wide range of salinity. In the Philippines, they naturally grow attached to marine fish cages and mangrove roots in brackishwater areas. Long utilized as food by coastal dwellers, the production of seaweeds for commercial purpose is fairly recent. Studies in the Philippines have shown that a good number of the coastal populations in the southern and central part of the country are presently engaged in full time seaweed farming. Thus, the production and post harvest techniques and methods for processing *Gracilaria* to produce agar suitable for local market is necessary to augment the meager income of coastal dwellers.

In India, seaweed collection is also an important source of income in fishing villages along the coasts, particularly the Ramanthapuram district in Tamil Nadu. *Gracilaria* spp. and *Gelidiella* spp. are collected through most of the year by men and women. A report by Kalkman in 1989 noted that the seaweed is sold to middle men very cheaply who then dry the seaweeds before selling them to processing industries. Thus, the village level method of extracting agar might be suitable for use in these parts of India in order for the villagers to increase their income.

In Thailand, a step by step method of crude agar extraction has also been formulated by the government's Biopolymer Research Unit. Its purpose is also to enhance income of coastal seaweed gatherers.

A flow diagram of a village level agar production is shown next page.

STANDARDS

It is important to know the acceptable standards specified by buyers of agar. It will help processors to have a rough estimate of the cost of their processed agar.

Here's a guide on the quality of dried seaweeds:

Class A: High price; moisture content is 18-20%. Single species dried seaweed. Clean, without contaminants of foreign materials such as shells, salts, sand, plastic, epiphytes, *Ulva*, crustaceans, corals, and mud.

Class B: Good price; single species dried seaweed. With minimal contaminants of foreign materials.

Class C: Low price; mixed species dried seaweed. Contain contaminants of foreign materials.

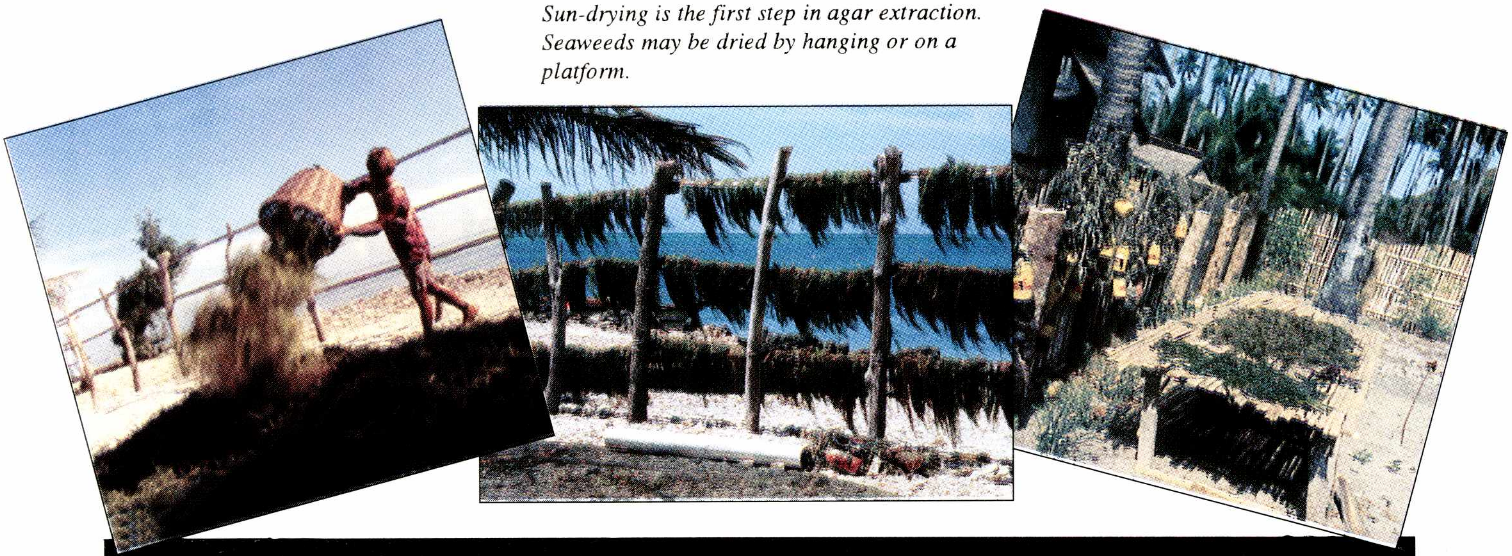
Specification of processed agar for Japan

Criteria	Grade			
	Special	1	2	3
Gel strength (g/cm^2)	600 or more	300 or more	250 or more	150 or more
Water content	22% or less	22% or less	22% or less	22% or less
Crude protein	1.5% orless	1.5% or less	2.0% or less	3.0% or less
Solid insoluble in hot water	0.5% or less	2.0% of less	3.0% or less	4.0% or less
Crude ash content	4.0% or less	4.0% or less	4.0% or less	4.0% or less

Agar specification of United States Pharmacopia (USP) and Food Chemical Codex (FCC)

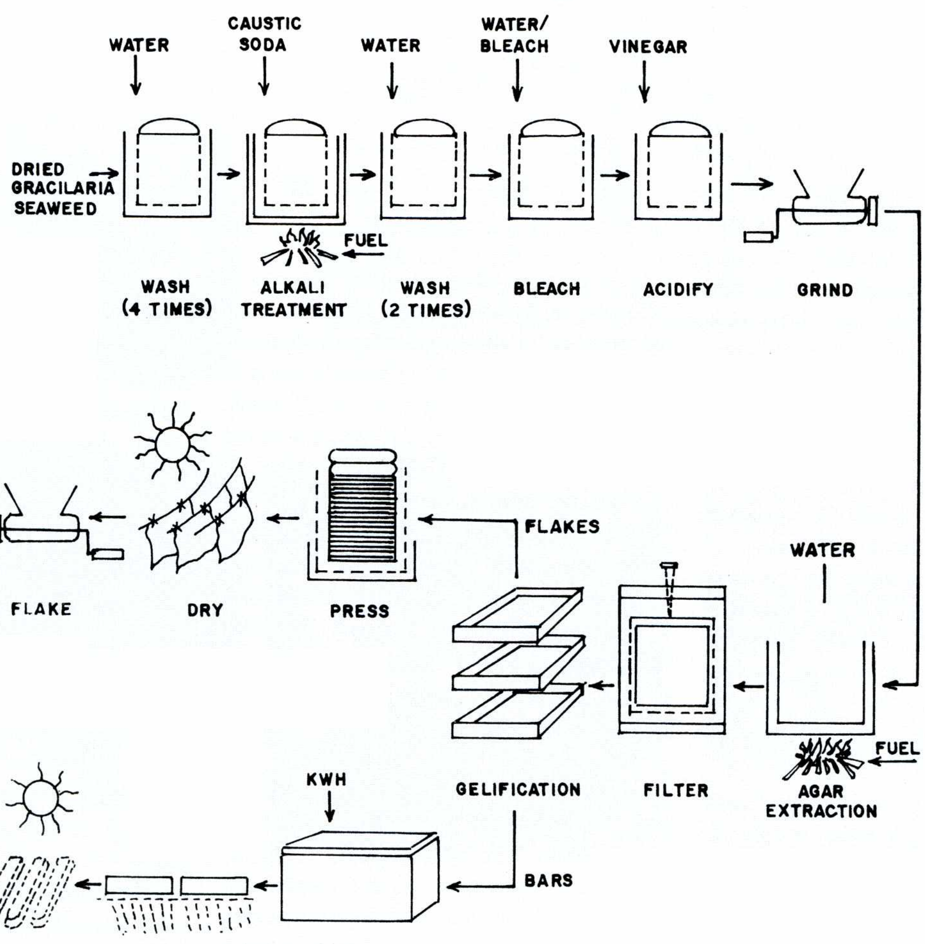
Criteria	USP	FCC
Microbial limit (*Salmonella*)	negative	negative
Maximum water content	20%	20%
Maximum total ash	6.5%	6.5%
Maximum acid insoluble ash	0.5%	0.5%
Maximum foreign organic matter	1.0%	negative
Maximum foreign insoluble matter	1.0%	1.0%
Arsenic	3 ppm	3 ppm
Lead	10 ppm	10 ppm
Heavy metals	40 ppm	40 ppm
Foreign starch	negative	negative
Gelatin	negative	negative
Maximum water absorption	75 ml	75 ml

Sun-drying is the first step in agar extraction. Seaweeds may be dried by hanging or on a platform.



Small-scale agar production

from dela Pena, PO. 1994. A guide to agar processing and quality of *Gracilaria* species. DA-BFAR; UN-FAO, Manila, Philippines.



Seaweeds: utilization and product applications

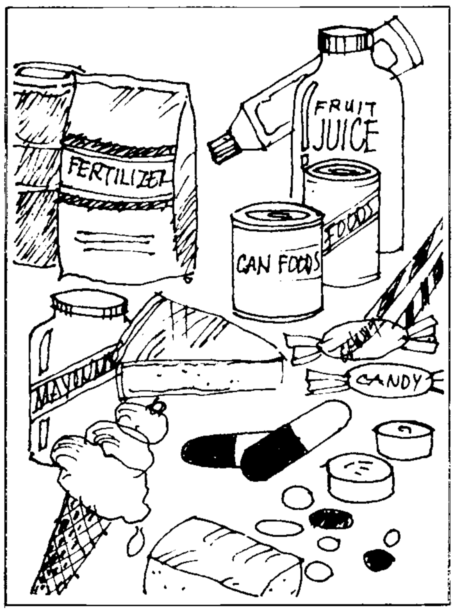
By **ET Aldon**

Seaweeds have been used as food, medicine, fertilizer, soil conditioner, and source of salt. As food, seaweeds are made into salads, boiled as vegetables, mixed with various species, pickled, cooked with coconut milk, for soup thickening, pudding and sweetened jellies in Asia. Seaweeds contain vitamins, proteins, minerals and iodine although these vary depending on species.

To some extent, raw or dried seaweed are used as medicine. Several studies have been carried out to determine the nature of compounds that could be of medical or phamaceutical use. It has been reported that Algasol, a compound in seaweed is useful for rheumatoid arthritis, bronchitis and emphysema. Its hypocholesterolemic activities lower blood pressure and blood cholesterol levels. They also possess anthelmintic as well as antihypertensive and anti-viral properties. The high iodine content is effective against goiter. It has also been reported to have use against cancer, fever, eczema, gall stone, gout, menstrual troubles, renal troubles, scabies, scofula, etc. Chemical properties of seaweeds, however, are said to vary from one species to another just like its nutritional values.

Basic chemical studies according to Cajipe (1990) have shown that seaweeds can be used as binders of heavy metal pollutants. Salt solutions from metals like lead, cadmium, copper, zinc, iron and mercury can be filtered by solution of pure seaweed polysaccharide or washed out through a column of ground dried seaweeds. Carrageenan and alginates reportedly exhibit a preferential affinity for lead and copper. *Sargassum* is being developed for this particular application.

For treatment of wastewater, Schramm (1991) suggested that seaweeds can be used



for biological removal of nitrogen and phosphorus in wastewater. They can take up ammonium, the prevalent nitrogen compound in domestic and urban sewage and agricultural and industrial water effluents. Chapman (1979) also noted its potential for water purification.

In agriculture, reports indicate that *Sargassum* contain auxin-like substances which are used as plant hormones and fertilizer. Indergaard & Ostgaard (1991) found that seaweeds are used not only as fodder for fur-producing mammals but also fish fodder for aquaculture. Seaweed meal treated with alkali is used as binder in moist fish feeds.

Realizing these potentials of seaweeds, research and development thrusts have been geared towards improving and developing its product applications. Today, various applications of seaweeds have been developed and improved. The polysaccharide extracts of brown and red seaweeds are good sources of phycocolloids which are important in gel formation. Its gelling properties make it a very important component in different industries. The major success in the seaweed industry is the development of phycocolloids with the following specific applications:.

Agar

Agar is extracted from *Gelidium*, *Pterocladia* and *Gracilaria*. Agar as an important product of red algae has a wide range of applications.

Food industry. Agar is used in cake toppings and icing, wafers, liquor, and salad dressing. Agar's good adherence to the base avoids cracks when applied to chocolates.It prevents dehydration in the preparation of jellies, marsmallows and candies or candy fillers in confectionery. They are good for clarifying coffee, beer, wine, juice and Japanese *sake*. Agars are good substitute for pectins requiring less sugar in making jams and maintains better consistency in yoghurts than casein. It serves as stabilizers or thickeners in sauces and allows sterilization without losing its viscosity or gelling power. A high concentration of agar added to glycerine or glycol provides a hard protective gel for food preparations.

Medicine and pharmaceuticals. Agar is used as laxative, stabilizer, and emulsifiers. When added to dietetic substances, it suppresses appetite by expanding within the stomach. They are expedient in many pharmaceutical preparations.

Agriculture. Agar is good in clone formation and propagation of orchids, ornamental plants, vegetables, fruit crops and other agricultural products. Seeds are pre-

next page

served from molds and bacteria.

Dentistry. Agar gel is used to make accurate dental casts and impression material in criminology, sculpture and tool making.

Other uses. Agars serve as lubricant in the processing of tungsten and tantalum. They prevent corrosion of aluminum and used as inhibitor in deep well cement and sulphur mining explosives. They are also used in the manufacture of ultra-sensitive photographic films and paint, batteries and graphite and glue preparation. They are used in the production of bacteriological plates (Blunden 1991;Chapman 1979) for identification of bacteria and fungi.

Carrageenans

Carrageenans are hydrophyllic colloids (water-soluble gums) which occur as matrix material in numerous species of red seaweeds. There are at least three types of carrageenan -- kappa, iota, and lambda.

Obtained from red seaweed like *Kappaphycus* and *Eucheuma*, among others, carrageenan can be used as emulsion, cough syrup and toothpaste. Carrageenan is a regulated food additive and current concern focuses on its safe molecular weight when eaten. Its most innovative development, Bixler (1996) reports, was the introduction of a food grade version of lower cost natural grade carrageenan which was developed in the Philippines. Applications of carrageenans make use of both their hydrophyllic and anionic properties. With potassium, it can also be used as a binding agent for tablets, in shaving creams and haircreams and as a blood anti-coagulant. It may also be used in providing growth of connective tissues and control of ulcers. Major uses are in food like dairy applications (ice cream, flavored and thickened milk, flans and milk puddings) and in meat and poultry (Bixler 1996).

Cajipe (1990) reported that carrageenan processed from *Eucheuma* is used as a medium for the growth of a wide spectrum of microorganisms, bacteria, yeast and other fungi.

The carrageenan industry grows as introduction of more product applications continue to grow. Another product is the liquid diet (Metrocal, Cambridge and Slim Fast) and Mc Donald's Mclean hamburger. With carrageenan, a cheaper pet food can be produced. Its use in powder form spread beyond pet food to air fresheners.

Alginates

Alginates are phycocolloid extracts of brown algae like *Laminaria*. They are used as emulsifiers and emulsion stabilizers in creams and lotion. Alginates are protection against many kinds of metal poisoning due to their ability to bind certain atoms. They are excellent suspensory agent for drugs and in the manufacture of greaselesss lubricating jellies. Alginates can form insoluble complexes with strontium. In cases when dairy products, cereals, or meat may be contaminated with strontium, the body uptake can be prevented by addition of alginate to the food. The strontium isotope is bound to the alginate and passes through the intestines without being absorbed into the body. If the body uptake is not prevented by alginates, the strontium is absorbed by the blood and deposited in the bone. This makes alginate both as a preventive and therapeutic measure.

Alginates are also recommended to inhibit absorption of lead and other contaminants like barium, cadmium and zinc contaminating food products which can raise blood lead level.

De Roeck-Holtzhauer (1991) suggested that a biomarine cosmetology can be developed using alginates. They are safe for use in skin applications. As a lubricating agent, they moisten and soften the hair and can easily be absorbed by the epidermis.

Seaweeds have slowly but definitely been becoming a major industry in the Asia-Pacific countries where they abundantly grow. In the Philippines, it ranks third among the export product after tuna and shrimp.

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Seaweed markets in southeast Asia

By **R Buendia**

World seaweed production has steadily increased over the years. China leads in harvests from aquaculture with 4.8 million tons followed by South Korea (650,000 tons), Japan (570,000 tons), the Philippines (465,000 tons), and North Korea and Indonesia with 110,000 tons each in 1995. Only small-scale farming of *Eucheuma* in Malaysia and *Gracilaria* in Thailand exist.

The three main commercial phycocolloids or processed chemical products from seaweeds marketed in Indonesia, Thailand, Malaysia and the Philippines are agar, alginate and carageenan. Corresponding seaweed sources for these products are known as agarophytes, alginophytes and carrageenophytes.

Agar

Gracilaria is the only source of agar in the Southeast Asian region. This agarophyte is mostly farmed in South Sulawesi, Indonesia where 5,500 tons are harvested yearly. Farmgate price in 1993 ranged from Rupiah 600-1,000 per kg depending on quality. Food grade agar production in Indonesia reached 980 mt in 1994. Most of these were sold in the domestic food industry market at an average price of US$22 per kg. In 1991, the country imported an estimated 169 mt of food grade agar (mainly from Chile) at US$18 per kg.

Although *Gracilaria* is not farmed in Malaysia, a small-scale agar extraction company (Algae Bio Tech) in Selangor processes 70 kg of dry *Gracilaria* imported from Thailand daily. The factory produces 8 kg agar per day which is sold at Ringgit 72 per kg. No other industrial production is known. Imported agar mostly in the form of agar strips comes from South Korea and are generally utilized in the preparation of jelly products.

Village level cultivation of *Gracilaria* in southern Thailand produces around 50-400 tons per year. Due to this low production, agar imported in Thailand has steadily been increasing. In 1993, 473 tons of imports were valued at Baht 226.48 million. On the other hand, only 7.78 tons valued at B3.50 million were exported. Some imported agar in Thailand were mixed with additives, repacked, and sold to Malaysia.

In 1995, only 2 tons of *Gracilaria* were harvested from seaweed farms in the Philippines. Most of the agar produced in the country are processed into agar bars (popularly known as "gulaman") and sold in the local market. Its retail price in 1993 was Peso 6.50-7.50 per bar (about 5 g) or P1,300-1,500 per kg. Imports sharply declined from 30,213 tons in 1990 to only 6,571 tons in 1992 probably due to price increases (from US$2.17 in 1990 to US$5.65 per kg in 1992).

Alginate

Indonesia, the only alginate producer in the region, manufactures 100 tons yearly mainly for its textile industry. Estimated imports in 1994 was 4,000 tons.

Malaysia imports around 60 tons per year from USA, Europe and Japan via Singapore. About 25 tons are used by food processors, 8 tons by the pharmaceutical industry and 10 tons in beer and salad dressings. Price estimates for alginate in Malaysia range from US$12-30 per kg depending on whether it is food, industrial or pharmaceutical grade.

Thailand also imports from the USA, Europe and Japan with estimates of 200 tons valued at US$4 million in 1994 (3% duty was imposed). The price of alginate in the country ranges from US$12 for industrial grade up to US$22 for food grade.

There is no available information for the Philippines.

Carrageenan

Total production of carrageenophytes in Indonesia was 21,180 tons (Rp 505 per kg farm gate price) in 1993. Almost all of these are exported to Hong Kong (used as fresh condiment) and Japan (refined and semi-refined). Currently, the country imports around 200 tons of refined carageenan for its food, beverage and pharmaceutical industries.

Limited production of carrageenophytes (about 1,500 tons per year) occurs in Sabah, Malaysia. There is no carageenan processor in the country. Yearly import of refined carageenan is 150 tons priced at US$12 per kg. This is distributed to the toothpaste (90 tons), milk-ice cream (30 tons) and food (25 tons) industries. Imported semi-refined carageenan for the production of air fresheners is around 10 tons per year valued at US$8 per kg.

Both carrageenophyte and carrageenan are not produced in Thailand. Imported semi-refined carrageenan (annual estimate: 780 tons valued at US$2.5 million) is consumed by pet food manufacturers. Meanwhile, the tuna processing and jelly/confectionery, and toothpaste industries use 120 tons and 100 tons imported refined carageenan with a value of US$2.4 and US$2.0 million, respectively.

In the Philippines, production of carrageenophytes mostly comes from the Sulu Archipelago in western Mindanao. According to the Seaweed Industry Association of the Philippines, there are more than 95,000 companies or families involved in *Kappaphycus* farming with a total area of 46,750 hectares. On the average, the farms produce 45-54 tons per ha per crop with 5-6 crops a year. There are also 10 processors for semi-refined carrageenan, three processors for refined carrageenan, and 10 carrageenan exporters.

The Seaweed Industry Association of the Philippines noted that the country produced about 24,000 tons of *Kappaphycus* (dry weight) in 1996 valued at almost US$20,000. The country processed semi-refined and refined carrageenan valued at US$31 million and US$23 million, respectively. Export sales in 1996 for dried *Kappaphycus*, semi-refined carrageenan and refined carrageenan amounted to over US$124 million, making the Philippines the largest supplier in the world market.

Future Prospects

With the currency crisis overshadowing the region, it is hard to determine the future of the seaweed market. Indonesia which is the only alginate producer and has a large market should focus on developing the industry. Malaysia and Thailand are foreseen to continue importing the phycocolloids because there is no viable large-scale farming areas in these countries. On the other hand, the carageenan industry in the Philippines is well-established, and is expected to maintain, if not increase, its output in the coming years.

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Cage polyculture (seaweed with grouper) at AQD's field office-laboratory in Malalison Island, west central Philippines. This trial was part of AQD's alternative livelihood program within the Community Fishery Resource Management Project.

CULTURE ... FROM PAGE 19

Luhan MRJ. 1996. Biomass and reproductive states of *Gracilaria heteroclada* Zhang et Xia collected from Jaro, central Philippines. Botanica Marina 39: 207-211.

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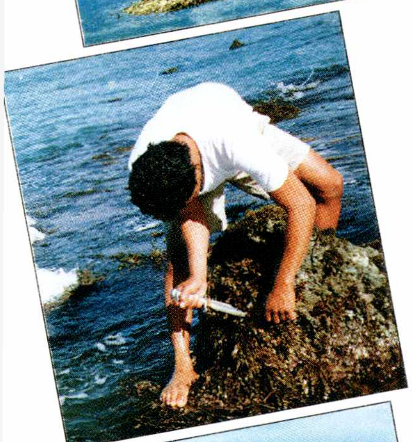
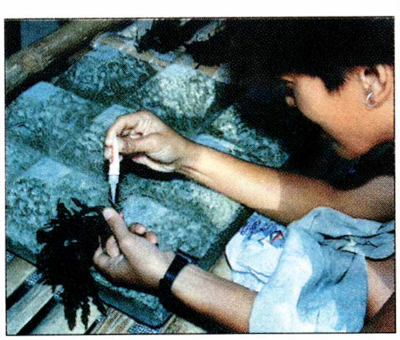
POSTSCRIPT: OUR COVER STORY

Like the mountains that no longer have trees, some of our country's coasts have lost their *Sargassum* beds. The reasons include overexploitation as *Sargassum* are of great value. These are used as fertilizers, as source of alginic acid, and in making commercial defattening soap, among other uses.



So, AQD attempted to replant *Sargassum* in Malalison Island, a coastal community in Antique. First, the researchers gathered seedstock from Hamtic where *Sargassum* still grows abundantly.

Second, they measured the seaweed so they would be able to determine growth.

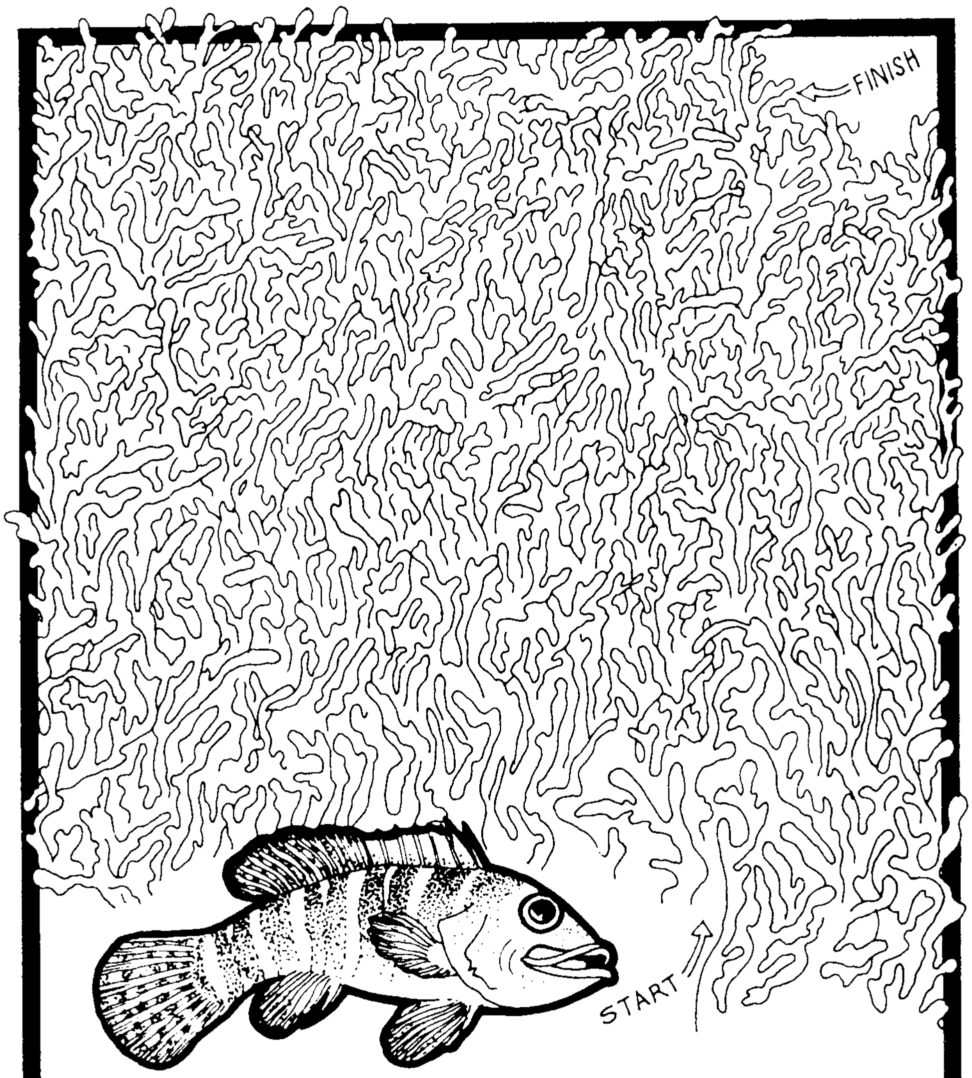


Then they planted the seaweed seedstock onto concrete blocks.

The concrete blocks were placed along the intertidal zone of Malalison. A net cage is placed on top to protect the seaweed from predation, increasing the odds for the growing seedlings.

Sargassum did not grow in totally depleted areas but it had a chance in less exploited areas.

AQD's results can only mean there is still hope for the *Sargassum*.



Navigating through 1998 will be tricky, what with the region's economic problems, not to mention environmental troubles. Navigating through 1998 may be as difficult as finding a way out of the coral maze. Always swim forward, if you come to a dead end, swim back through the coral and try again. Do not give up.

***SEAFDEC in Malaysia ...* from page 1**

ment and Management Programme but was given over to SEAFDEC by FAO in 1996.

(2) A project on designing and testing a turtle excluder device (TED). Sea turtles are usually caught with shrimp, and TEDs can assure that shrimp catch does not include turtles especially since turtle populations have been seriously reduced. This has also prompted MFRDMD to set up hatchery facilities, and to compile regional statistical data on collection and tagging of marine turtles.

MFRDMD activities also cover training and information. It conducts training on marine fishery biology, oceanography, population dynamics, stock assessment and management.

MFRDMD publishes periodicals and reports, and maintains databases to facilitate information transfer. Recently, it conducted regional workshops on fishery resources, fishing gears, and shared stocks.

MFRDMD has echo-sounding facilities and remote sensing data capability. A satellite receiving system that monitors oceanographic parameters of the region was installed in 1996).

***AQD in 1997* ... from page 1**

schools in east central Philippines.

AQD also consolidated its information activities, publishing only one bimonthly newsletter beginning June 1997, placing a website in the Internet, and utilizing the mass media (mainly print) to some extent to publicize program results.

Regarding industry feedback and participation to AQD's R&D activities, 1997 has clearly defined three levels of industry involvement.

The first level is industry participation in R&D planning workshops which are designed to fine-tune AQD's research programs.

The second is the involvement of fishfarmers in field-testing AQD technologies. For AQD, private fishfarms have become demonstration sites to ensure more rapid commercialization of its technologies. For the farmer, there is assurance of technical support and a way of relating directly to AQD researchers. For AQD researchers, this will ensure immersion in the industry.

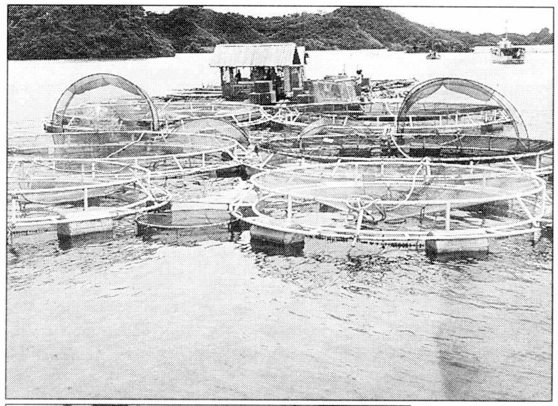
The third level is training and information support. Training courses can be tailored to the needs of requesting parties, while requests for information is attended to speedily. The AQD Library in particular holds the latest information in tropical aquaculture. For 1997, it increased holdings by more than 500 volumes.

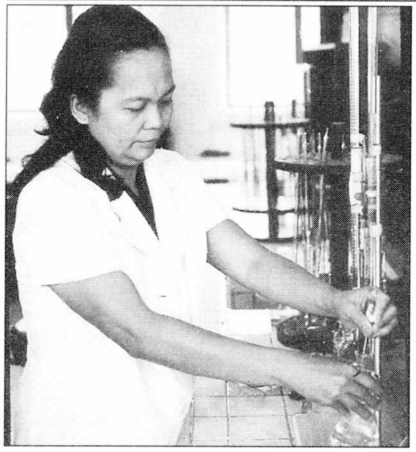
Indeed, 1997 can be seen as the definitive year of industry linkage. Incidentally, it marks the second year of the change in AQD thrusts. Back in mid-1996 when Dr. Rolando Platon assumed the AQD Chief post, he promised to "have a strong hand in technology verification and aquaculture extension, and bridge the gap between AQD's considerable research output and the industry's need for sustainable technologies ... AQD must verify and then demonstrate and extend the technologies it can generate."

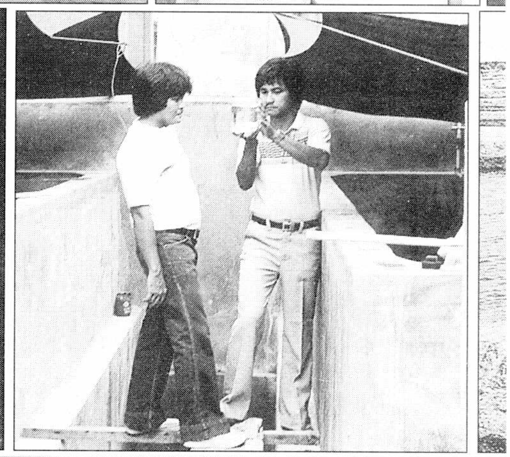
Glimpses of the past

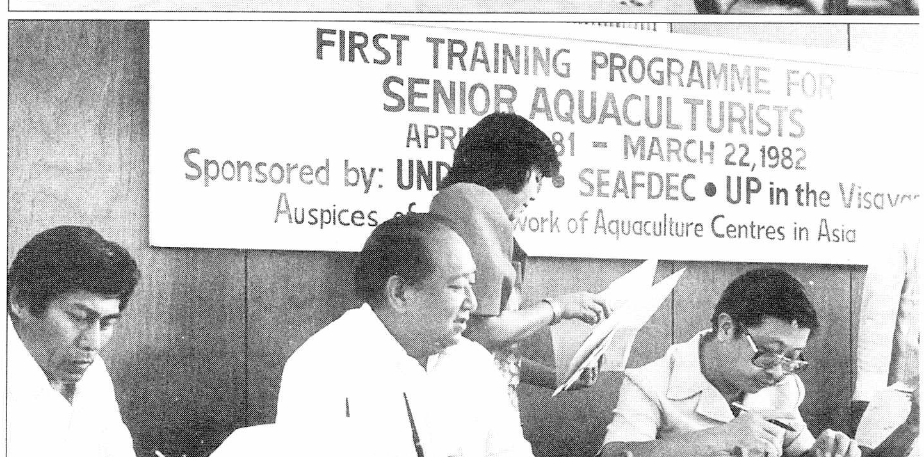
PART 2 of 4

AQD in 1980-1985









The first half of the '80s was exciting for AQD. Breakthroughs were achieved and four Chiefs were appointed within five years.

Highly influenced by a 20-year scenario in world fisheries and aquaculture, AQD consolidated and focused its research activities from commodity-oriented research programs to three aquaculture systems, namely: mariculture, brackishwater culture and freshwater culture. This new research thrust gave primary consideration to the effect of aquaculture on the environment and the sustainability of production.

Three major stations were created: the Tigbauan Main Station, Leganes Research Station and Binangonan Research Station. In 1981, Dr. Flor Lacanilao replaced Mr. Kunio Katsutani who acted as Chief from September to December 1980 after Dean Rogelio Juliano resigned in August 1980.

AQD's operation and organization was further streamlined during Dr. Lacanilao's term. For instance, the SEAFDEC (formerly Asian) Institute of Aquaculture was abolished and replaced by the Training and Extension Division. A Research and Development Program Committee (RDPC) was created to determine the research directions of AQD. Another committee met monthly to discuss new aquaculture technologies and problems encountered by fishfarmers.

Major research achievements in 1980-1985 were:

(1) sexual maturation and spontaneous spawning in captivity of 3-5 year old milkfish broodstock at Igang in July-October 1980. The broodstock came from wild fry grown in Leganes which were later transferred to Igang's floating cages. This achievement was repeated in May, June and July 1981.

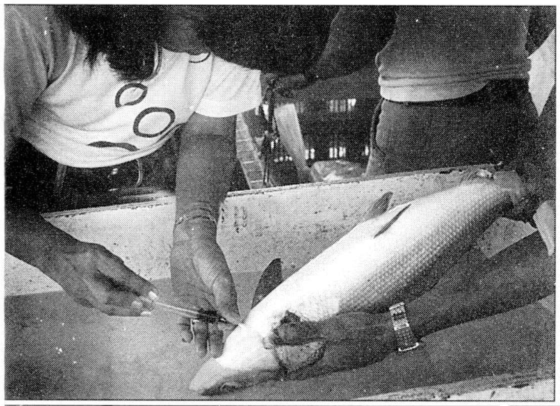
The life cycle of milkfish was completed with the successful spawning of a hatchery-bred milkfish also at Igang (1983). This achievement bolstered the Philippine government's National Bangus Breeding Program launched on December 27, 1980.

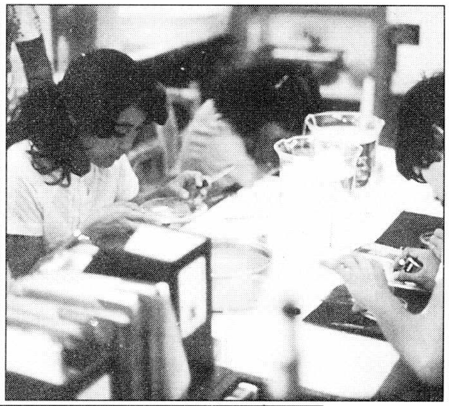
(2) the first successful induced spawning of sea bass, *Lates calcarifer* Bloch, in the Philippines in Leganes (1983)

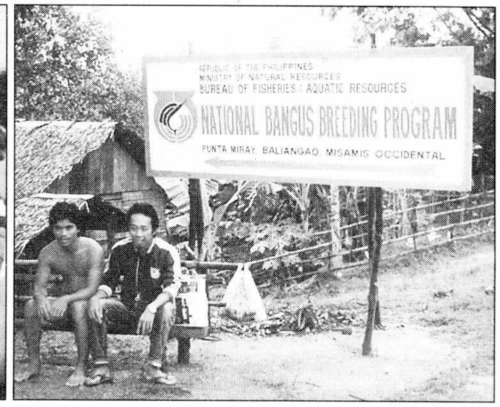
(3) induced spawning in captivity of the grey mullet *Mugil cephalus* and the siganid *Siganus guttatus* (1981)

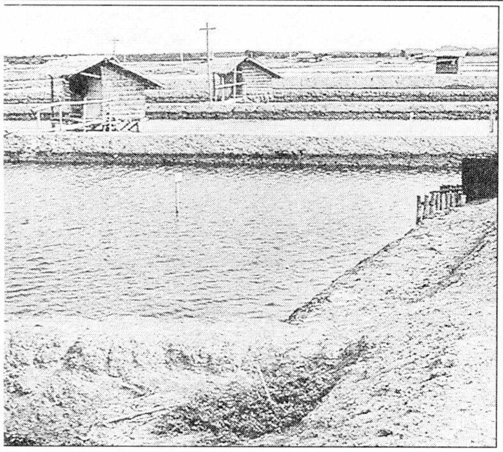
(4) induced spawning of the bighead carp *Aristichthys nobilis* in Binangonan Research Station (1985)

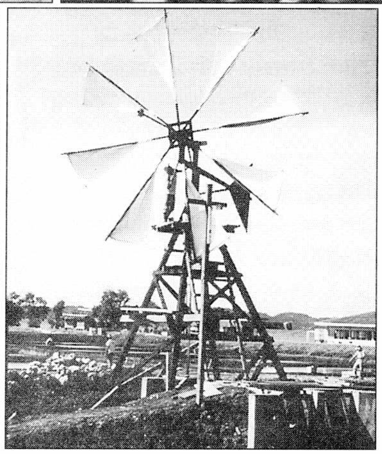
(5) induced spawning of the Asian moon scallop *Amusium pleuronectes* and rearing of its eggs

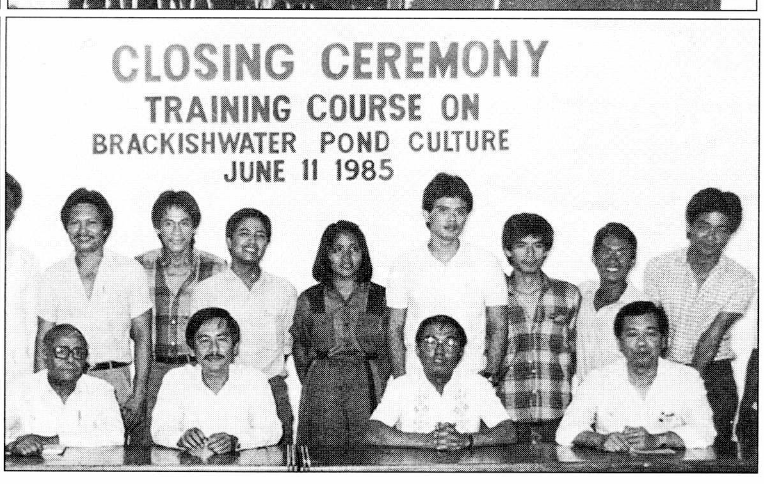












from larval to settlement stage (1985) and the

(6) completion of the life cycle of window-pane shell *Placuna placenta* (1980).

AQD collaborated with the Southeast Asian Regional Center for Graduate Studies (SEARCA) and launched the Aquabusiness Project Development and Management (APDEM) Workshops in 1980 for executives of aquabusinesses and aquaculture institutions. The following year, AQD became a training center for Asian aquaculturists, having been designated as the Regional Lead Center of the Network of Aquaculture Centres of Asia (NACA). The Brackishwater Aquaculture Information System (BRAIS), a specialized information analysis project involving five Southeast and South Asian countries and the computer-based Aquaculture Information System (AQUIS) were approved and implemented in collaboration with the International Development Research Center (IDRC) of Canada and the Aquaculture Development Programme of FAO/UNDP.

In technology assessment, AQD collaborated with the Ministry of Human Settlements, the National Irrigation Administration (NIA), local government units and pond owners in establishing social laboratory projects to make aquaculture a viable economic source for rural development (1985).

AQD hosted several local and international conferences and workshops during this period. These are: (1) the regional symposium on the culture and use of algae in Southeast Asia (1981); (2) the round-table discussions on problems related to the use of hormones in the induction of gonadal development and spawning of tropical fishes (1981); (3) the second international milkfish aquaculture conference (1983); (4) aquaculture and development symposium (1983); (5) the first international conference on the culture of penaeid prawns / shrimps (1984) and the (6) national prawn industry development workshop (1984).

1983 ended the first decade of operation of AQD. As it embarked on its second decade, Dr. Alfredo Santiago, Jr. was appointed Chief. In consultation and upon the recommendation of the RDPC, new research and production-oriented programs on the economically important aquatic species -- fishes, crustaceans, molluscs and seaweeds -- were instituted to be more relevant and to keep up with the changes in the aquaculture industry. - **RY Buendia**

Mail from our readers

OCTOBER 1997 ISSUE ON SEABASS CULTURE
Christine Campbell e-mailed additional information on algae for hatcheries:

The Culture Collection of Algae and Protozoa, here in the UK supplies algal starter cultures for bass and bream hatcheries in the Mediterranean. For the healthy development of the larvae, assisting their growth into marketable adults, we recommend that farmers use a combination of algae for feeding to the rotifers. For instance, the Tahitian Isochrysis *(CCAP 927/14) will grow to high densities at up to 30 C and produces relatively large amounts of the essential fatty acid docosahexaenoic acid (DHA).* Nannochloropsis oculata *(CCAP 849/1) is also very easy to grow and provides a source of eicosapentaenoic acid (EPA) another essential highly unsaturated fatty acid. European farms routinely culture both these strains along with* Tetraselmis suecica *(CCAP 66/4) for 'greening the water'. True chlorophyte algae, such as* Chlorella, *may provide adequate protein for the lavae, but if fed on this alone the resulting diet will be deficient in essential fatty acids. For more information on how to obtain our algal strains please contact CCAP by phone or fax or visit our web page at: http://www.ife.ac.uk/ccap.*

Culture Collection of Algae and Protozoa
Dunstaffnage Marine Laboratory
PO Box 3, Oban
Argyll, Scotland PA34 4 AD
Fax 44 1631 565518
E-mail: CNC@wpo.nerc.ac.uk

We missed out one important paper on sea bass larval rearing that should have been included in the AQD research publications on seabass: **AC Fermin, MEC Bolivar and A Gaitan**. 1996. *Nursery rearing of the Asian sea bass,* Lates calcarifer, *fry in illuminated floating net cages with different feeding regimes and stocking densitities.* Aquat. Living Resour. 9: 43-49. Our apologies, Andy.

JUNE 1997 ISSUE ON ABALONE CULTURE
Dr. Hugh Thomforde of the University of Arkansas at Pine Bluff (hthomforde@lonoke. uaex.edu) e-mailed his request for the address of Mr. Philip Cruz who was featured in our "People in Aquaculture" section. Apparently, the two were classmates in their M.S. Fisheries course at the University of the Philippines in the Visayas, Iloilo City, and had lost touch of each other.

Pradip Sen from Bangladesh needed more information on binding techniques for abalone diets especially starches and alginates that were developed in Australia. Mr. Sen wrote that his firm is one of the leading shrimp / fish / poultry farms in the country, complete with a feed mill. If any of our readers have the information he requested, send it to:

InterExports International Ltd.
47, Dilkusha CA, 3rd floor
Dhaka - 1000, Bangladesh
Fax 880 2 83 3433 or 880 2 956 8480

Other readers like **Sidik Dewanto** of Pt. Mega Marine Pride in Indonesia (cmaster@rad.net.id) wanted to order the books we listed as very useful references for farmers and aquaculturists.

30 September 1998
IS THE DEADLINE FOR THE

Photography competition on women in Asian fisheries

Asian Fisheries Society
MC PO Box 2631
Makati City 0718 Philippines

Feedback re AQD programs

Mr. RM Borromeo Jr. from the Philippines wrote of his interest in *lapu-lapu* (grouper) culture after visiting the Sanson farm in Bacolod City where AQD has a technology verification project. "*... we are impressed with AQD's assistance to their farm. (Mr. Sanson) is now shipping his production to Manila. Your people there has really helped him a lot. (This) is very commendable ...*" He also wanted to know if there is a similar program in Davao. (None to date. - Ed.) Presently, he farms milkfish in cages and in ponds.

30 August - 3 September 1998
Baltimore, Maryland USA

Third International Symposium on

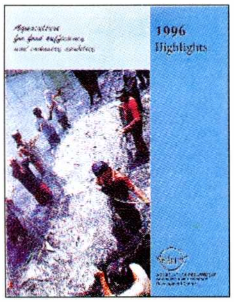
AQUATIC ANIMAL HEALTH

SYMPOSIUM WEBSITE:
http://www.som1.ab.umd.edu/AquaticPath/issahweb

OR WRITE:

Division of Comparative Medicine
Johns Hopkins University
School of Medicine
720 Rutland Avenue
Baltimore, Maryland
21205-2196 USA

New publications, training courses NOTICES



1996 Highlights of SEAFDEC Aquaculture Department's R&D

Edited by J CARREON-LAGOC
1997, 12 pages

Discusses very briefly AQD's accomplishments in 1996. This year marked a change in AQD's thrusts, with AQD taking a strong hand in technology verification and technology transfer even as it continued research on economically important food fishes in the region.

Summarizes research studies on milkfish, mudcrab, giant tiger shrimp, grouper, sea bass, snapper, marine ornamental fish, Nile and red tilapia, catfish, abalone, seaweeds, and the community fishery resources management in Malalison Island.

Technology Verification Projects are described along with training and information activities.

The report noted two important conferences AQD hosted in 1996: the *Second International Conference on the Culture of Penaeid Prawns and Shrimps* and the *Meeting on the Use of Chemicals in Aquaculture in Asia*.

1 9 9 8
AQD TRAINING COURSES

Aquaculture Management	March 16 to 30
Fish Health Management	April 15 to May 26
Marine Fish Hatchery	June 16 to August 5
Freshwater Aquaculture	August 20 to September 30
Shrimp Hatchery Operation	September 16 to November 5
Fish Nutrition	October 14 to November 24

For application forms and further information, please contact:

Training and Information Division
SEAFDEC Aquaculture Department
Tigbauan, Iloilo 5021, Philippines
Tel/fax: **63 (33) 336 2891**; E-mail: **seafdec@mozcom.com**

For local applicants who wish to apply for fellowships, contact:

The SEAFDEC Council Director for the Philippines
c/o Office of the Undersecretary for Attached Agencies
Department of Agriculture
Elliptical Road, Diliman, Quezon City 1104
FAX: 0 (2) 927 8405

For fellowship applicants from other countries, please contact your respective SEAFDEC Council Director.

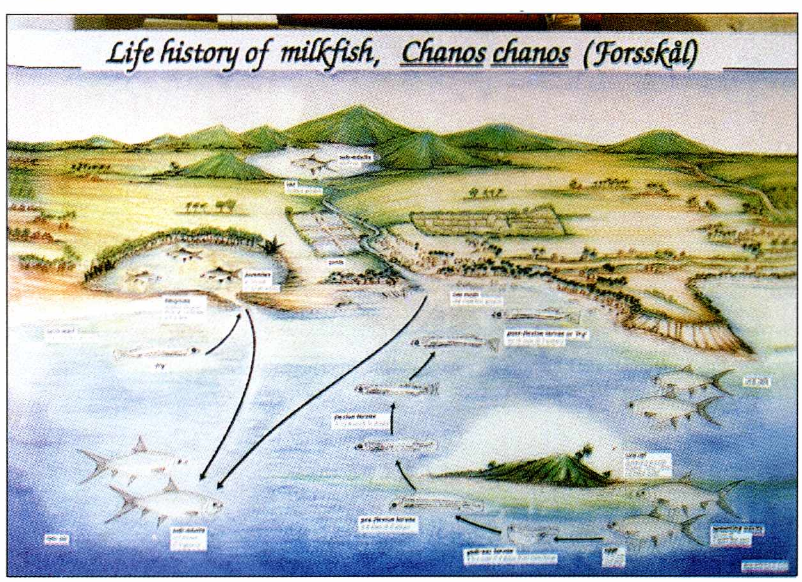
FOR ORDERS, WRITE TO:
SEAFDEC/AQD, P.O. Box 256
Iloilo City 5000
Fax (63-33) 336 2891, 335 1008
E-mail tms-seafdec@ phil.gn.apc.org
seafdec@mozcom.com

AQD's website at: http://www2.mozcom.com/~seafdec

LIFE HISTORY OF THE MILKFISH

83 x 61 cm COLORED POSTER
By the AQD Museum and Biodiversity Garden
Price: ₱50 or US $20 (includes postage)

TRACES the life history of milkfish based on Dr. Teodora Bagarinao's monograph published by AQD in 1991, and on her paper entitled *Systematics, distribution, genetics, and life history of milkfish* published in the Environmental Biology of Fishes, Vol 39 (1994): 23-41.



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SEAFDEC
Aquaculture
Department
P.O. Box 256
Iloilo City 5000
Philippines

The Southeast Asian Fisheries Development Center (SEAFDEC) is a regional treaty organization established in December 1967 for the purpose of promoting fisheries development in Southeast Asia. Its Member-Countries are Japan, Malaysia, the Philippines, Singapore, Thailand, Brunei Darussalam, and the Socialist Republic of Viet Nam. Four departments were established in the Member-Countries; the Aquaculture Department (AQD) located in the Philippines pursues aquaculture research and development.

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Contributions

We accept articles that focus on issues, developments, and information on all phases of sustainable aquaculture for publication in this newsletter. Photographs and line drawings must be camera-ready, glossy B&W prints or colored slides.

Cut-off date for contributions considered for the issue indicated is every 1st of January, March, May, July, September, or November.

Gifts and exchanges

Publication exchanges with *SEAFDEC Asian Aquaculture* are also encouraged. AQD has publications exchange agreements with 800 institutions worldwide.

Subscription

Subscription per year (six issues): ₱300 (local surface mail), US$ 40 (foreign air mail). Please make remittances in postal money order, bank draft, or demand draft payable to SEAFDEC/ AQD.

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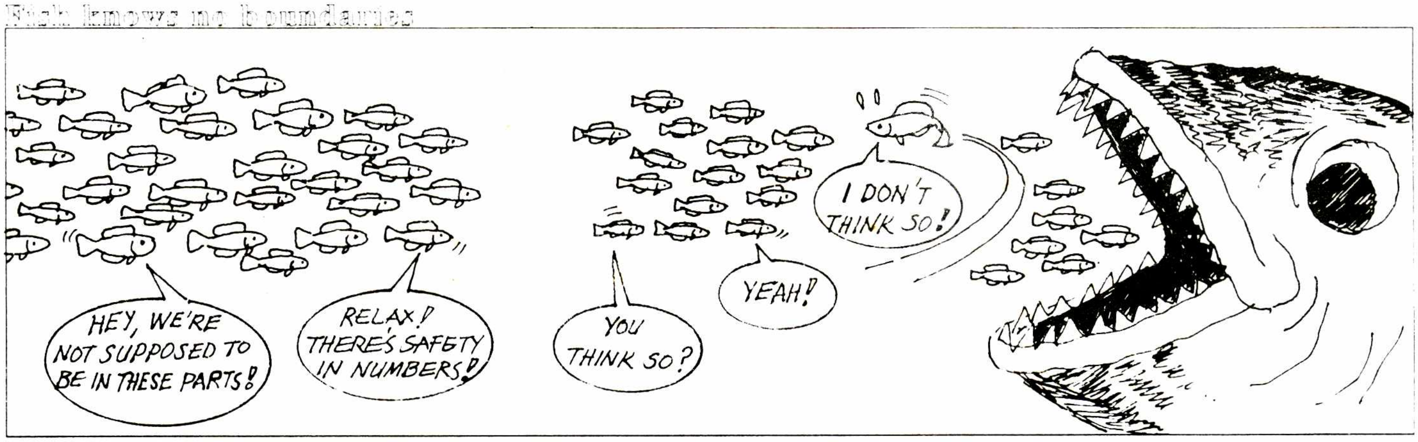
Fish knows no boundaries



a.p. surtida

Better life through aquaculture